JOURNAL

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OF THE INSTITUTION OF ELECTRICAL ENGINEERS

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THE FRONTIERS OF ELECTRICAL ENGINEERING AND PHYSICS

MANY MEMBERS OF THE INSTITUTION MUST ON occasion look at the pages of the *Proceedings* with astonishment, and indeed dismay, at the complexity of some of the problems discussed. As electrical engineering has progressed over the years it has become increasingly necessary to dig deeper into the physics of the subject and to analyse more precisely the behaviour of instruments and equipment. This has made some of us acutely aware of the limitations of our early training and of the need to-day for a much wider background in basic studies. At the same time it is evident there can be no relaxation in the standards of practical experience dealing with the problems of design, production, installation and operation of equipment, which The Institution sets for its members. The requirements for corporate membership emphasize the importance of all these things.

One cannot help reflecting that the maintenance of the present pace in the acquisition and application of new scientific knowledge will present an ever more difficult problem, and one wonders sometimes how the young electrical engineer is going to find it possible in the future to prepare himself adequately for his life's work. Broadly, the answer must surely lie in the better correlation of scientific ideas and their application. It is astonishing how often the same basic approach to the analysis of a problem can be used in widely different fields of study, and our teachers have a duty of the first importance to lighten the burden of their students by using every opportunity towards that end.

It takes all kinds of electrical engineer, representing a wide variety of interests, to make up a balanced professional group, and The Institution has very wisely and properly opened its doors to those engaged in allied branches of applied physics. It is impossible sometimes to distinguish the work of the physicist from that of the engineer, even if one wished to do so, and this is particularly true on the light-current side of electrical engineering. Phenomenal progress has been made during the last two or three decades in using the discoveries of physics to meet the requirements of the engineer. We recall the ever-growing achievements in electronics, microwaves, semi-conductors and the harnessing of nuclear energy for electric power generation, as but a few of the developments to which we can point with justifiable pride. In spite of all the difficulties that electrical engineers have had to meet in a period of unprecedented demands upon them, no one can deny that they have faced up to their responsibilities fairly and squarely.

The frontiers of electrical engineering and physics offer a rich harvest, and in that domain lies the spearhead of the technological development on which our future prosperity as a nation must depend. At the same time we must not overlook the fact that there is a big gap between the discovery of a new physical phenomenon and its successful application. Years of patient hard work, not particularly thrilling or attractive, are often required to bridge that gap but in the end something truly worth while will surely emerge.

The lesson we learn, with renewed emphasis as time goes on, is that The Institution must remain, as always, fully representative of all branches of the professional work for which its members stand. Therein lies its strength and its opportunity to provide a forum of the kind required for the exchange of knowledge and the discussion of problems leading to progress for the benefit of the community at large.

THE START OF THE NEW SESSION

THE INAUGURATION OF SIR GEORGE NELSON

During a meeting full of interest, borne along by speeches of wit and distinction, the traditional ceremony of inauguration was carried out on the 6th October, 1955, when Sir George H. Nelson, Bart., M.I.Mech.E., succeeded Mr. J. Eccles, C.B.E., B.Sc., as President of The Institution. An abstract of Sir George's Presidential Address is published on page 732.

THE inauguration of a new President is always a popular ceremony in The Institution, and the Opening Meeting of the new session on the 6th October, 1955, maintained the now traditional high standard. On these occasions the unity of the electrical engineering profession is perhaps more apparent than on any other; the Address provides a fundamental theme embracing the multifarious branches of the subject and often ranging far beyond, and members may spend an absorbing evening contemplating their profession not only as a technology but as a powerful force in the affairs of mankind.

Before the start of the meeting the Library became so crowded with members, and their ladies and guests, seeking refreshment and meeting old friends that the more experienced soon drifted down to the Lecture Theatre to make sure of securing a seat. The expectations of the assembly were fully realized by the President's stimulating Address and by the speeches which followed it.

Mr. J. Eccles took the Chair at 5.30 p.m. with **Sir George H. Nelson** seated on his left. Many members of Council, officers from related learned societies and other distinguished guests were among the audience. After the Chairman had announced the latest contributions to The Institution's benevolent funds and had announced that the Council had appointed Mr. C. T. Melling as an Ordinary Member of Council, under Bye-law 54, to fill the casual vacancy created by the election of Sir Hamish MacLaren as a Vice-President, he welcomed eleven new Corporate Members with the customary greeting.

The Chairman shook hands with each new member and presented him with a specially bound copy of "The Institution: Its Objects and Organization."

Premium Certificates were next awarded to the authors of outstanding papers submitted during the 1954–55 Session. As he presented the John Hopkinson Premium Certificate to Sir Gordon Radley for his part in the paper "A Transatlantic Telephone Cable," the Chairman said he would like to take the opportunity of announcing that the Christopher Columbus Prize for Communication, which is awarded by the City of Genoa annually—and in every fourth year for outstanding work in the field of world telecommunication, had been awarded jointly to Dr. Kelly of the Bell Telephone Co. and Sir Gordon Radley for their work on the transatlantic telephone link. In the name of the assembled company the Chairman offered Sir Gordon sincere congratulations, and the announcement was received with great applause.

The climax of the evening was now approaching and the Chairman continued:

"It is now my pleasure to invite Sir George Nelson to deliver his Presidential Address. Sir George requires no introduction to an electrical audience anywhere in the world. Least of all does he require an introduction within the precincts of this building where, despite his arduous duties as Chairman of a large group of electrical manufacturing companies, he has over many years provided our members and our Council with the wisdom and guidance which he has been able to bring to bear on our deliberations and on the advancement of this Institution.

"At this stage, I do not wish to say more, because more will be said later on. It is now my pleasure, in your name, to extend to Sir George our congratulations on his accession to the Presidency and to invite him to deliver his Inaugural Address."

Amid prolonged applause Sir George rose to speak (see page 732).

The President's Address was loudly acclaimed and Mr. Eccles asked **Col. B. H. Leeson** to propose a vote of thanks to Sir George. Col. Leeson said:

"It is my privilege to express to our new President, Sir George Nelson, our deep feelings of appreciation and gratitude for his thought-provoking and far-sighted Inaugural Address—an Address worthy of the vision of our first President, to which you, Sir George, have so aptly alluded, and of the treasured traditions of this Institution.

"The opening meeting of a new session is a most exhilarating experience. It is like arriving at some new vantage-point in the early dawn and watching the morning mists below slowly roll away and reveal the new terrain ahead.

"In his Address to-night Sir George—unlike the man who viewed the mist and missed the view—has turned a traditional blind eye on those things ahead which in the misty light of little knowledge loom large and ominous but which in the light of greater understanding and perception assume their true significance and are only of passing consequence. At the same time Sir George has put a telescope to his far-seeing eye and with clear perception and common-sense judgment he has picked out and focused our attention on those things in the coming years which will be of vital significance and of

lasting consequence, not only to the future prospects of the engineering profession and industry and to the well-being of our nation, but also to better living for all peoples throughout the world.

"Sir George's Address has created two clear and vivid impressions in my mind. The first is a pleasant impression of the prospects and responsibilities of the engineer, the scientist, the technologist, the technician, and of others in the years that lie ahead. Their task must be to produce more food and more materials. To men, especially the young men, in these walks of life, the future is rich in prospects and opportunities for service and adventure.

"The second impression is of the world-wide tragedy, which, as the President so rightly emphasizes, can and must be averted. I imagine a potter, highly skilled in his manipulative and creative art, working at his wheel. The wheel revolves with ample power from nuclear energy but his face is wrought with anxiety and foreboding as he surveys his declining store of clay; while his wife—like Old Mother Hubbard—stares sadly into her bare cupboard!

"Turning from this challenge in the Address—and the challenge must be taken up—to the coming session, we wish you, Sir George, a very happy term of office. Your fellow members pledge their whole-hearted and loyal support in all that you will do, and do so well, to promote the aims denoted in our Royal Charter.

"And now I wish to say how delighted we are to have Lady Nelson with us to-night. Lady Nelson, as the wife of our esteemed President, you have an all-important role. It is a role that we ourselves know very well you will fill with much grace and dignity. But what we wish to impress on you is how appreciative and grateful we will be for all the many ways in which during the session you will help and serve our Institution. May I add that just as you will be concerned in keeping your husband in good health, we will see that he does not lack good spirits!

"This vote of thanks to our President would be lamentably lacking if I did not refer to the signal distinction of the baronetcy which Her Majesty the Queen conferred on Sir George in the Birthday Honours List last June. Lady Nelson, the members of The Institution share with you the pride that you must feel in the great achievements of your husband and in their recognition. Sir George, we congratulate you most heartily on your baronetcy—a distinction which you have so rightly and richly deserved.

"And now to conclude. To-night in his Inaugural Address and from his presidential quarter-deck, Sir George may be said to have made the signal 'The Institution expects every member will do his duty.' Now it is my honour and duty in company with Sir Hamish MacLaren to hoist our signal flags—flags which strung between us in their colourful array and flying in the friendly air of this assembly make the signal, 'That the best thanks of the Institution be accorded to Sir George Nelson for his interesting and instructive Address and that with his permission the Address be printed in the *Proceedings of The Institution.*' "

The Chairman called upon **Sir Hamish MacLaren** to second the vote of thanks. Sir Hamish said:

"The day before yesterday my wife had the honour of launching one of Her Majesty's ships, a function that seems to give women a thrill only exceeded by that resulting from the birth of their own offspring—and attended by considerably less inconvenience. At the beginning of the ceremony, when all the V.I.P.'s are safely installed on the launching platform, it is the custom for the youngest apprentice in the shipyard, with a bright and shining face and a clean set of overalls, to scramble up and present the lady who is launching the ship with a bouquet of flowers. On Tuesday I was very sorry for this apprentice, and I feel very much like him to-night, on this my first public appearance as your junior Vice-President, particularly following such a past-master as Col. Leeson.

"I am very conscious of the honour which was bestowed on me in electing me as a Vice-President of this old and honourable Institution—not old as Institutions of this old country go, but old in relation to the application of electrical science to modern life and civilization. I am also appreciative of the opportunities which that office will give me of serving our Institution and serving also a profession which has provided me, and is providing me, with such an absorbingly interesting working life.

"Talking of age makes me think of Sir George's reference to his fifty years' run from Student to President. As a Scot I cannot refrain from reminding him that he is now no longer required to pay an annual subscription.

"Our incoming President has, in his Address, pointed

Mr. J. Eccles presenting the John Hopkinson Premium to Sir Gordon Radley

the way ahead with the vision which we should expect from the creator of the great industrial organization of which he is the head. What a man! His interests lie from under the sea and on the sea, to land and air, and in wide travel on land, on sea and in the air. If he has not so far travelled under the sea, at his convenience we shall be delighted to arrange for that, and, with due notice, in a submarine propelled by machinery of his own manufacture.

"He has made it clear to all of us that we have no reason to rest on our conquests of the past. There lie ahead many worlds to conquer, so that in this profession we need none of us suffer as did King Alexander, who said at the age of thirty that he could see no further worlds to conquer.

"With these very brief and, I know, inadequate remarks, I have great pleasure in seconding the vote of thanks proposed by Col. Leeson to our incoming President for his most inspiring Address."

The vote of thanks was carried with enthusiasm and Mr. Eccles said it was his very pleasant duty to invite Sir George Nelson to occupy the Presidential Chair. He then vacated the Chair in favour of the incoming President, who at once called upon **Sir Harold Bishop** to propose a vote of thanks to Mr. Eccles. Sir Harold said:

"I have the pleasant task of proposing a vote of thanks to Mr. Eccles, the retiring President. It always seems to me that no sooner have we got used to our President, and he, for his part, has acquired some knowledge of the job which he is supposed to do, than we throw him out and put somebody else in his place! In fact, of course, for those other than the President himself the year passes in a flash. But change is inevitable, because our democratic way of running this Institution of ours requires it. More important than that, it is quite impossible for a busy man to stand the strain of being President of The Institution for more than one year. That, indeed, is a point I should like to stress. It is a great honour to be President of The Institution, but the load of work for a man who is already fully occupied in his own business is astonishingly high. His spare time, his evenings, his week-ends all go on Institution work, or at any rate in trying to catch up with the work he ought to have done for himself. I am credibly informed that the leaning tower of Pisa said to Big Ben, 'You have the time and I have the inclination.' But of our Presidents we require both in the fullest possible measure, and that brings me to my first personal reference to Mr. Eccles. Naturally I, with others here, have seen a great deal of his work. I can assure you that this Institution has been very well served in the past year.

"Mr. Eccles came to this office only a short time after he was appointed to succeed Sir John Hacking as Deputy Chairman (Operations) of the Central Electricity Authority. He had the disturbance of moving his family and himself from the North to London and the very considerable problem of dealing with a new and bigger job. But in spite of all that, it is not necessary for me to tell you, he has acquitted himself magnificently.

"His Ulster toughness, if I may call it that, and his dry humour have stood him in good stead. I do not know whether he has exhausted his fund of after-dinner stories. Maybe he has, but I should just like, for a few moments, to refer to some of his work as our President.

"His philosophical Address a year ago will be remembered by all of us. He has during his time of office been very much concerned with the development, which Sir George mentioned just now, of nuclear energy. He has, in fact, been concerned with it in two ways. First, his position as a Deputy Chairman of the Central Electricity Authority means that he is responsible for major decisions connected with nuclear power station development. Secondly, he has contributed a great deal to the formation of the British Nuclear Energy Conference. This body, set up by the three major Institutions in association with The Institution of Chemical Engineers and The Institute of Physics, will ensure that the British contribution to this most important subject is fully documented and published. The idea was mooted before Mr. Eccles became President, but he has borne the brunt of the work in carrying it through with, of course, his colleagues in the other Institutions. We ought to be very grateful to him for what he has done.

"There is one other matter I want to mention. I refer to Mr. Eccles's work for higher technological education. We keep talking about this, but there is no subject of greater importance to the future welfare of our profession. Mr. Eccles has devoted a great deal of his time during his year of office to explaining The Institution's point of view to the Minister of Education and his officers. And I can tell you that that is a fairly heavy job. We think we know best. The three Institutions have not achieved all they had hoped for, but substantial progress has been made. It is fair to say that the representations which the three Institutions have made have been reflected in the Minister's decisions.

"Our retiring President has the delightful facility of making informal speeches of the most apt kind. That, you know, is of inestimable value to The Institution in helping to co-ordinate and unify the work at headquarters with what goes on at the many Centres and Sub-Centres throughout the country. We have had, during his period of office, that feeling of leadership which is a most powerful force in the work of our Institution. Mr. Eccles has led The Institution with great skill and ability and good humour. He has an instant grasp of the complicated issues which arise in our work, and an admirable manner in guiding the work of Council. He is an extremely able public speaker, whether the subject be light or serious.

"Without vanity we in this Institution may regard ourselves as belonging to an historical family, which has continued throughout several generations and which numbers amongst its sons many distinguished engineers. I venture to say to you—and I am sure you will agree—that none has been more distinguished or more worthy of The Institution's thanks than our retiring President.

"I now have great pleasure in proposing: 'That the best thanks of The Institution be accorded to Mr. J.

Eccles for the very able manner in which he has filled the office of President during the past year.' "

The President asked **Sir Gordon Radley** to second that vote of thanks. Sir Gordon said:

"It is almost a tradition that the Senior Vice-President should be asked to second this particular vote of thanks and one for which there is good reason, as there is for most of our Institution traditions. In this case it gives the Vice-President and his fellow Vice-Presidents reason to pause and consider the burdens and responsibilities that surround the Presidential Chair, lest by any conceivable chance one of them should, in his turn, be called to fill it. It also impresses us with the high standard of service to The Institution set by each one of our Presidents in turn, a standard enhanced during the past year by Mr. Eccles.

"I must confess that there has been a certain lack of liaison between the two sides of the communication business in this country and Sir Harold Bishop has said many of the things that I intended to say. Last year, when he stepped aside for Mr. Eccles, he wondered how Mr. Eccles would face the dual task of his ordinary work and of being President of The Institution. I cannot add to what Sir Harold has said, except to say that the membership at large does not fully realize the many things that the President has to attend to during his year of office.

"Personally—and I think I speak for my fellow Vice-Presidents—I should like to thank Mr. Eccles for the unfailing consideration that, despite his own commitments, he has shown for us and our responsibilities during the past year.

"Here I would seek to widen the vote of thanks and to include Mrs. Eccles. I am sure she must have had a very large share in producing Mr. Eccles to fill the Presidential Chair so promptly and so ably at each meeting and keep him there smiling while he listened to so many long and tedious speeches, including I am afraid, too many from myself. Also, this Presidential business must have meant to both of them the loss of many leisure hours together.

"A little time ago Sir Edward Appleton reminded us of some words written by Sir Francis Bacon in the seventeenth century. He quoted them, I think, as a challenge from the scientist to the engineer, and they run like this: 'For there is no comparison between that which we lose by not trying and by not succeeding; by not trying, we throw away the chance of an immense good; by not succeeding we only incur the loss of a little human labour.'

"Mr. Eccles has both tried and succeeded, and with that thought in mind, I have very real pleasure in seconding the vote of thanks so ably proposed by Sir Harold Bishop."

The vote of thanks was carried with loud applause, and the President presented Mr. Eccles with the Certificate of Presidency. **Mr. J. Eccles** replied by saying:

"Thank you, Sir Harold and Sir Gordon, for the kindly words that you have seen fit to say of me. Although my year of office has been a busy one and, indeed, a very pleasant one, looking back upon it, there is not really much to show for one's labours.

"It is quite true, as the President said, that we produced a film. Some of us became film stars overnight, and we hope (but not on that account) that the film will do some good in helping the future generations to decide where the opportunities do arise. We also made a petition for amendment of our Charter. Then we had some interesting negotiations with my namesake, the Minister of Education, and he is also tough. I personally feel that as a result we have formed a basis on which further collaboration can take place.

"Those of us who were privileged to attend the Summer Meeting in Scotland will long remember the organizing ability, the kindness and courtesy of Mr. and Mrs. Hastie, Mr. and Mrs. de Villiers, the members of the Scottish Centre Committee and, indeed, all our members there who gave us an experience outstanding for its pleasure and its profit.

"As someone has said to-night, the duties of a President are extremely numerous and sometimes onerous. When one has a full-time job to do as well, the real consolation is that there are only twenty-four hours in each day. But through it all it may well be that the Scottish poet spoke truth when he said,

> One crowded hour of glorious life
> Is worth an age without a name.

At any rate it is devoutly to be hoped that the English poet was not infallible when *he* said,

> The evil that men do lives after them,
> The good is oft interred with their bones.

"We have had a great number of interesting speeches to-night and I do not want to detain you any longer, but before I ascend a steep ladder to a vacant place on a high shelf, I should like to take this opportunity of thanking all the members of this Institution, especially Members of Council, and very specially the Vice-Presidents, for their forbearance, encouragement and generosity during my year of office. I should also like to thank Mr. Brasher and all his staff for making my task so easy and for handling the executive work of The Institution with vision and efficiency.

"And if I may, I should like to express a special word of gratitude on behalf of The Institution to Mrs. Brasher, who, with such grace and charm, sacrifices so much of her personal time in our interests.

"I am glad you mentioned my wife. This speech would not be complete if I were not to express my own very warm thanks to my wife who kept me fit, who saw that I got there on time and appropriately dressed, and who always managed to face life with a smile, however long the journey or however late the hour. She has, indeed, been a very present help in trouble.

"Now, Sir Harold and Sir Gordon, thank you very much indeed for exaggerating my virtues and suppressing my defects, and thank you all for approving the one and ignoring the other."

On the conclusion of the speeches the President closed the meeting.

Journal I.E.E., December 1955

SIR GEORGE NELSON'S INAUGURAL ADDRESS

"Past, Present and Future"

The following is an abstract of the Inaugural Address delivered by the President, Sir George H. Nelson, Bart., M.I.Mech.E., before The Institution on the 6th October, 1955. The complete text and illustrations will appear in both Part A (February, 1956) and Part B (January, 1956) of the Proceedings.

I THANK YOU for the honour conferred on me in electing me President and I shall, with all your help, do everything possible to uphold the traditions and high standards of this great Institution, and I am especially pleased that the election comes on the fiftieth anniversary of my admission to The Institution as a Student.

The theme of my Address has three sections—past, present and future.

I will start the picture of the past with our first President, Charles William Siemens. In his Address to the first meeting of our Institution—then called The Society of Telegraph Engineers—in February, 1872, he pointed out that what then seemed to be separate compartments of science and engineering were really one. He said:

> There is hardly a problem in electrical science that is not of practical interest to the telegraph engineer

and he mentioned various phenomena which

> . . . involve questions belonging just as much to pure physical science as to the daily practice of the telegraph engineer.

He concluded:

> These remarks may suffice to show how great is the field of our activity and how much remains to be accomplished notwithstanding the extraordinary progress of which we are apt to boast.

Our Institution was to see its original name changed twice in less than eight years, first to "The Society of Telegraph Engineers and Electricians," in 1880, and then to its present name in 1888. Our work had progressed so much by 1921 that a Royal Charter was granted, in recognition of The Institution's central role in establishing high professional standards and propagating and encouraging the science and technology of electricity.

To show the progress that has been made in the use of electrical energy, I would mention that in 1905 many generating plants were of the order of only a few hundred kilowatts, powered by reciprocating prime movers, and that the total generating capacity in Great Britain was 1 700 MW, being only 1/20 kW per head of population, whereas this year the total generating capacity in Great Britain has reached 25 500 MW, or $\frac{1}{2}$ kW per head of population—a tenfold increase. The capacities of individual generating sets have risen in fifty years from a few hundred kilowatts to over 100 MW and, quite recently, sets of 200 MW have been ordered.

These developments have brought about a steady fall in the cost of electric power in comparison with the cost of living over the past thirty years, amounting to more than 45%. The advances in the design of electrical equipment have come from great imagination, courage, and enormous expenditure on research and development by the electrical manufacturing industry financed almost entirely from its own resources.

The diagram indicates some of the technical changes that have taken place in turbo-alternators in the past forty years. These changes have been made possible by new techniques—including the introduction of hydrogen cooling—arising from research.

In the telecommunication field progress has been staggering. Fifty years ago few homes had a telephone, Marconi's monumental achievement in transatlantic radiocommunication was only four years old and there was no system of radiocommunication as we know it to-day. The first patent for wireless was only taken out in 1896, and a British company, formed the following year, was the first to bring wireless telegraphy to the world.

What further advance in productivity in other industries will result from a combination of electric power and electronic methods of process and machine control one can only guess, but the fields for such application are unlimited.

Next come the gains from the use of the electronic computing machines, which are already saving man-months of engineers' and mathematicians' time, solving a variety of problems. In fact, the availability of these machines has enabled problems to be solved which until

recently could not be tackled, owing to the effort needed for their solution.

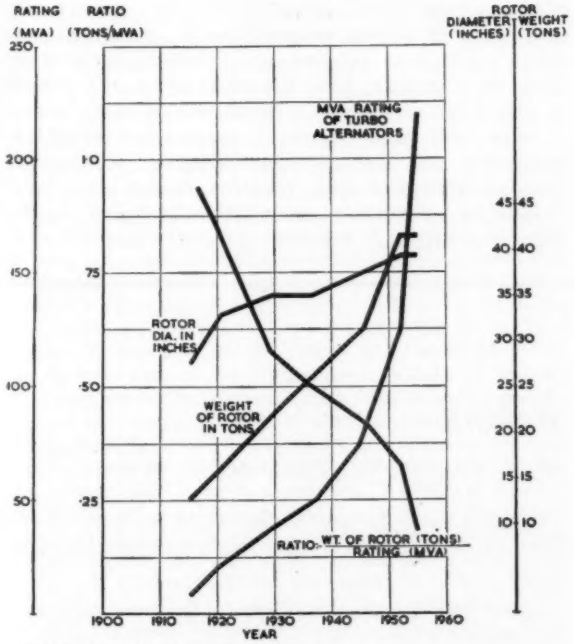
With these brief comments on the achievements of the past and present, I will now turn to the prospects of the future.

From my extensive travels oversea, and from discussions with those carrying the highest responsibility in many countries, I have found an almost unanimous determination in all nations to improve their standard of living, and they all realize that the key to this lies in the greater application of electric power to the source of their national economy, including agriculture, communications and industry. This brings increased responsibility to the electrical engineering profession and industry now.

It has been estimated that the population of the world has risen from 1100 million in 1850 to 2400 million in 1950, and that by the year 2050 it will have increased to 2½ times the 1950 figure, reaching the gigantic total of 6000 million. Over half of to-day's population are living in areas where there is an immediate and continuing pressure for improvement in economic standards.

These estimates, although not exact, suffice to indicate that both living standards and world population, steadily and substantially rising, will increase the demand for more and more electric power.

At the recent Geneva Atomic Energy Conference, it was stated that by the year 2000 the world consumption of energy would be not less than the equivalent energy of 7500 million tons of coal a year, representing a threefold increase in total energy consumption in the next fifty years.



Development of turbo-alternators

These prospects compel us to recognize the needs and compel us to solve the problems which will arise from the steady exhaustion of conventional fuels and basic materials.

Fortunately, under the pressure of the need to defend our way of life, we carried on great research and development in the field of nuclear physics; through this solutions are being found to the exhaustion of conventional fuel in the development of the means of generating electric power from nuclear energy.

The solution of the fuel problem in electricity generation is therefore undoubtedly in sight, but this is not the only problem with which we are faced in meeting the needs of improving the standards of living of the world and of a growing population. However, just as research and development in nuclear physics provide an alternative source of heat for generating steam, so equal and intensive study, research, and development in fundamental physics will provide alternative sources of supply of other basic materials, and these must be followed up immediately.

It has been estimated that the rate of exhaustion may easily become an acute problem in 100 years, which is a very short period in which to solve problems of such immense and fundamental character as producing appropriate artificial substitutes, or synthesizing heavy elements from lighter ones.

I feel that the Council and the members of The Institution are to be congratulated on their vision in agreeing that The Institution should play its part in founding the British Nuclear Energy Conference in association with four sister Institutions. To make most rapid progress from research and development in the field of nuclear physics it is necessary to embrace the sciences, the technology and the engineering of all the Institutions concerned.

It cannot be denied that benefits have come from development to create the means of destruction. It is possible that the discovery of the hydrogen bomb may make the risks of war so terrible that man will not face its consequences, and I hope that, with such an instrument, our statesmen will succeed in convincing possible aggressors that war cannot be contemplated. If this happens, armies and navies will be much smaller, and consequently it will be possible to release many scientists, technologists and engineers from warlike studies in order to play their part in the improvement of world conditions. Pride can be taken in the results which have so far sprung from the remarkable co-operation between scientists, industrialists and the Government in war time. It is heartening to find that our Government is continuing to pursue a similar policy in peace time in the field of nuclear physics, the research and development of which are enormously costly and which could not possibly be borne by individual firms.

I must issue a warning that the release of scientists and technologists from activity on war equipment will not be sufficient to solve all the problems to which I have referred in my Address, and The Institution, therefore,

must continue to play its part by pressure and by advice in order to overcome the shortage of technical manpower, not only in this country but also in the Commonwealth.

I sincerely hope we shall be successful in convincing both parents and boys that the study of science and engineering can be just as powerful in forming well-rounded human minds, and will develop at least as good character, as the traditional subjects which we know as the humanities. It is particularly necessary to attract a great proportion of the young people who still choose to pursue the arts, in spite of the need for technologists for the improvement of the world.

Further interest could be stimulated by increasing substantially the numbers of well-qualified teachers in mathematics and science subjects in secondary schools; also by arranging that effective steps are taken to explain to boys of General Certificate of Education level the opportunities of a career in scientific rather than non-scientific subjects, so influencing the transfer of promising boys from one side to the other.

I would say that I support very strongly the warning issued by the Barlow and Percy Committees—that on no account must the demand for quantity be allowed to lower the standards of quality. Some people think that The Institution is raising its educational requirements above what is necessary, implying also that it is limiting recruitment to the profession. Nothing is further from the truth, for The Institution, while supporting the policy of increased quantity with quality, is pursuing an energetic campaign to attract a larger share of the output of boys from secondary schools to take engineering courses and so increase the input to the technological field.

A very important phase of the supply of technical personnel is the urgent need for technically qualified men who have the natural gifts for management. The ideal men for such appointments undoubtedly are those who are qualified in science and technology and who, in addition, have the inborn qualities of character, powers of leadership and that rarest of all senses—common sense—the combination of which earns the respect and confidence of others.

Such qualities are born in men and are not made by education. The greatest problem is to catch the person as soon as these characteristics appear, and to develop his natural gifts in association with scientific and technical education. The supply could be increased by appointing as school careers masters men who have the gift of spotting them, and who can ensure that they receive appropriate training. The adequate supply of future managers is fundamental, because the best results from design, manufacture and operation can come only with efficient management intimately familiar with the widest aspects of the business concerned.

Great Britain has very few natural resources and without doubt its scientific, technological and skilled people are its greatest economic asset. This being so, they must be employed in the most efficient manner and their use on duplication or further multiplication of effort on the same problems should be avoided, in the interests of the nation and Commonwealth. Unfortunately, we have not yet reached that degree of rationalization in industry necessary to achieve this important position.

During my visits as a Vice-President to the Local Centres, questions were raised about the need for more papers on the management and practice of research, manufacture and operation of electrical machinery and on equipment in all fields. I sincerely hope that the Council and the Papers Committee will take note of this, and that members who can present such papers will respond to this very important request.

The fear of imminent exhaustion of supplies of basic materials did not trouble our predecessors in 1872, nor was it serious as recently as 50 years ago, but it is with us to-day and is not just a vague question for the future. If a lowering of the standard of living through the exhaustion of natural resources is to be avoided, immediate action to produce synthetic substitutes of all kinds must be taken now. Electrical engineers will have to play a prominent part in these developments, which, in turn, will bring increased responsibilities to The Institution for ensuring that adequate numbers of qualified electrotechnical scientists, technologists and industrial administrators are available for this vital work; these responsibilities will undoubtedly be met.

Glancing . . .

Ahead

A year ago the December issue of the *Journal* hinted at its impending metamorphosis. While it would be misleading to suggest that change on a similar scale will be taking place in next month's issue, we might perhaps warn those who have this year been collecting red paper for Christmas decoration that the *Journal* will no longer be a profitable source, and assure others who suspect that there is something slightly different about the text pages next year that they will probably be quite right.

Behind

MEETING CRITICISM BOTH WAYS

"In conclusion the author tenders his apologies to the members for the length of the paper, and for the omissions in it."

[*From a paper read at an Institution meeting in December, 1905, and published in the Journal.*]

The Revised Examination Regulations (1953)

and their effect upon exemption from the Institution Examination

The Institution's new Examination Regulations issued two years ago came as a shock to many lecturers and students whom they affected. In common-rooms, in laboratories, in hostels, the cry went up that The Institution was becoming too academically minded and even that it was trying to restrict the size of its corporate body, a charge which Sir George Nelson has recently refuted again in his Presidential Address. However, their practical operation and the second, considered thoughts on them which time has allowed have revealed to many of the dismayed that the Regulations are not so fearful after all, that the Committee Room in which they were drafted had not really walls of ivory, and that a Part III to the Institution Examination is not unjustifiable. The whirlwind of modern technological development now buffets the engineer with poor educational foundations so mercilessly, that all those with vision must comprehend the wisdom of the Council's decision—to insist on a scientific foundation both broad and deep for the future professional electrical engineers of Great Britain. On no other basis can the electrical industry maintain its initiative.

The Institution is yet on the transitional journey bridging its old and new Examination Regulations. But already the pattern of the other bank is clear, though some details will remain misty until the Council for Awards in Technology (under the chairmanship of Lord Hives) have had time to show the design of the standards they propose to set up: this article sets out in general terms how the structure of exemption from the Institution Examination is now taking shape. We emphasize that for some time the qualifications of many students seeking exemption will need to be treated individually on their merits and that those in doubt about their positions are encouraged to write to the Secretary for guidance.

Early Days

FOR many years, as the status of the professional electrical engineer was evolving, success in a university or college examination was not considered essential for an aspirant to Corporate Membership of The Institution. But in time it became clear that to establish and maintain high professional standards, some written investigation of a would-be Associate Member's mental ability was a *sine qua non*. Often a past examination for a university degree or a college diploma provided this, but in 1913 The Institution set up its own examination, whose purpose was to test the academic knowledge and ability of practical engineers who had not had the advantage of a formal education in electrical engineering. Since then numerous changes in it have occurred and for some years the purpose of the Institution Examination has been to serve more as a yardstick by which to measure other examinations—university, college, or professional—than as one which will be taken by a substantial proportion of the membership. In fact, nowadays, only about 8% of the new Corporate Members satisfy The Institution's educational requirements entirely by means of its own examination.

The syllabuses of the present examination are the model on which the teaching syllabuses of many technical colleges are based and they form a standard by which other qualifications are judged in relation to exemption from the Institution Examination.

Development of the Institution Examination

The latest revision in The Institution's Examination Regulations will shortly become fully operative. What are the bases of it?

The current and growing expansion in the applications of electrical science will in the years ahead bring new technological problems to those now qualifying as electrical engineers, when they come to occupy posts of major responsibility for electrical work. So rapid are the developments that the new techniques of to-day will often be out of date in a few years' time and shortly afterwards become a matter for some future historian of engineering. There is, however, a broad basis of fundamental and unchanging science and technology which is added to but slowly with the years. It is this broad foundation which it is essential to impart to the young engineer, for on it he will build a superstructure clad in the technology of a particular branch of electrical engineering which is bread and butter to him at the moment but from which he may turn to some other branch as his career dictates. It is only with such personal equipment that the electrical engineer will solve his problems. Far better that he spends the time of his formal education in acquiring it rather than in becoming familiar with transient facets of the subject: it will be time enough to deal with these when he is employed in industry or research. These inescapable facts were the prime movers in the generation of the revised syllabuses.

The New Structure

The Engineering Institutions Examination, Part I, is now common to the Institutions of Civil, of Mechanical, of Electrical and of Municipal Engineers, and to the Institute of Marine Engineers. The Part I subjects of the revised examination are English, Mathematics, Principles of Electricity, Applied Mechanics, Heat, Light and Sound, and Engineering Drawing, the last of which will not become compulsory for electrical engineers until 1957. Apart from English, these form a group dealing with the basic science common to all engineers. In Part II of The Institution's own examination Mathematics, Electrical Engineering and Engineering Physics (or Thermodynamics) are carried to more advanced stages to meet the particular requirements of electrical engineers. In Part III the peak of the pyramidal structure of fundamental science and technology for electrical engineers is found in the subject of Advanced Electrical Engineering—a peak that lies at the centre of a range of specialist subjects. This, together with the subjects of Parts I and II, forms the foundation on which the specialized work of the electrical engineer is based, and it is at this level that specialization first appears in the Institution Examination. Two specialist papers are taken in Part III; the two subjects of these are selected by the candidate from eight special subjects.

Exemption from the Examination

Students of electrical engineering may, of course, obtain exemption from the Institution Examination through various educational qualifications, and we now pass on to consider this process. The "Schedule of Accepted Educational Qualifications," published in 1951, has become obsolete and a new edition is being prepared in terms of the 1953 revision of the Examination Regulations. Universities and colleges have been invited to submit full particulars of the syllabuses and hours devoted to the various subjects of their courses, and these have been examined to determine the extent to which they meet The Institution's educational requirements for Corporate Membership.

University Degrees

In general the standard and content of degree courses remains satisfactory for success in them to allow complete exemption from the examination. Engineering degrees are viewed as a whole for exemption purposes and not on an individual-subject basis in relation to the Institution Examination, but their electrical engineering content is carefully evaluated. Degrees in natural philosophy and physics vary enormously in their content of electrical science and therefore it is difficult to generalize on the exemption that will be granted. For Special or Honours degrees in physics, with electrical science as a major part of their syllabuses, complete exemption will be granted to candidates who have obtained first-class honours. On the other hand, where a general degree has been taken in which electrical engineering figures little more than as the Principles of Electricity of Part I of the Engineering Institutions Examination, the candidate will normally be required to take the two Electrical Engineering papers of Part II and the whole of Part III in order to satisfy the educational requirements completely. However, we would point out that any science graduate has, if necessary, an opportunity for his educational qualifications to be reconsidered when he has satisfied the other requirements for election to the class of Associate Member.

Qualifications from Colleges of Technology

The courses held at colleges of technology are assessed for exemption by comparing the syllabus for each subject included with the corresponding one of the Institution Examination, and by considering the time devoted to these studies.

College Diplomas. Associateships or Diplomas are awarded at most of the major colleges of technology after full-time courses; many of these have already made approved modifications to meet the more stringent requirements demanded by developments in electrical science and technology, and there will be no critical date for students seeking exemption from the Institution Examination via one of these qualifications.

Higher National Diplomas. Courses leading to the Higher National Diploma in Electrical Engineering have been the subject of special individual attention, since they vary considerably in content and standard. Some of them satisfy only the requirements of Parts I and II, and students taking them will need to complete a further course of approved study and to pass Part III of the Institution Examination for complete satisfaction of the educational requirements for Corporate Membership. Other H.N.D. courses have been suitably modified so that they are now approved by The Institution and those who are successful in them will obtain complete exemption.

Industry-based Sandwich Diploma Courses. The increase in standard of the Institution Examination has been imposed, not arbitrarily, but in order to maintain the future standard of professional competence indicated by Corporate Membership. The increased standard, however, has made a full course of part-time study to achieve professional qualification very arduous and this has led to the development of a third stream of students, who achieve their qualifications by what have become known as *industry-based sandwich diploma courses.* These courses normally consist of alternate periods of six months in industry and in a college of technology for a total period of four or five years. When deciding on the extent of the exemption to be granted with reference to a particular industry-based sandwich diploma course, the Examinations Committee consider not only the course itself, but the equipment and staff available, both in the electrical engineering department and in other departments of the college. It is only when all of these are satisfactory that complete exemption is granted. Where these facilities are not available, but there is the intention, say, of building new laboratories or adding to the staff, the college will be placed in the exemption category for which it qualifies at the moment and consideration will be given to re-classification when the improvements have taken place.

Classification of Technical Colleges. For convenience of discussion, colleges of technology are divided into three categories.

In Category A are colleges with well-equipped laboratories for electrical engineering and supporting subjects; their staff is of adequate quality and sufficiently numerous to deal with the quantity of students attending professional courses in electrical engineering. The award granted on completion of industry-based sandwich diploma courses at these colleges may be the Higher National Diploma, if the course has been approved by the Joint Committee for National Certificates and Diplomas, or the Associateship or Diploma of the individual colleges. For the former award the papers set by the colleges and the candidate's answers to them are assessed by The Institution, and for the latter, the standard of the internal examinations is maintained by a Moderator approved by The Institution. When the course has been approved by the Examinations Committee of The Institution, successful candidates will be granted complete exemption.

Colleges classified in Category B are those being built up to the same standard but which are not at present entirely satisfactory in respect of either staff or laboratories. Students who have been successful in approved courses at these colleges will be granted exemption from Parts I and II, and will be allowed to take Part III of the Institution Examination without attending any further course in preparation. This will not seriously handicap the students, but will mean that they will have to demonstrate that they have achieved the required standard through an external examination at the Part III level instead of through an internal one as in Category A colleges.

There are other colleges which have successfully held part-time courses leading to the Higher National Certificate in Electrical Engineering, but which are not equipped to provide full-time or sandwich diploma courses of Part III standard, and these fall into Category C.

National Certificates. In Category C colleges, part-time courses may be recognized for exemption from Parts I and II

only, and students will be allowed to take the examination for Part III, only after attending a further course in preparation. If these courses are to be taken on a full-time basis, it will be necessary for students to go to one of the colleges in Category A or Category B. Part-time courses in preparation for the Part III examination will however be held at certain Category C colleges, where the necessary equipment is available and there are individual members of the staff who are approved for teaching these advanced subjects. Recognition of them might have to be withdrawn if the staff of the college changed —for there is of course a shortage of highly trained engineering lecturers—and the stability of such courses will be less than those in the major colleges.

Exemption from the Institution Examination through National Certificate courses will still continue, though, as previously mentioned, this route will now become exceedingly arduous. Courses which previously gave complete exemption from the Institution Examination on attainment of the Ordinary National Certificate with credits in the two electrical subjects, the Higher National Certificate with credits in the two electrical subjects and credit standard in approved courses in Mathematics, Applied Mechanics and Heat, Light and Sound, will generally give exemption from the corresponding subjects of Parts I and II of the revised Institution Examination, and students will need to follow additional courses in Engineering Physics (or Thermodynamics) to obtain complete exemption from Part II. Some of the work of the Higher National Certificate course will cover part of the syllabuses of Advanced Electrical Engineering and the special subjects of Part III, but it will be necessary to do another two years of part-time study in order to take Advanced Electrical Engineering and the two special subjects of Part III. This course could include at least part of the additional work required in Engineering Physics (or Thermodynamics), and in that event the student would be allowed to take Engineering Physics (or Thermodynamics) of Part II with Advanced Electrical Engineering of Part III, before taking separately, if he so chose, the two special subjects of Part III. From this it will be seen that a candidate who obtains exemption from the S.1 year of the Ordinary National Certificate course will need six years of part-time day and evening study to obtain exemption from Parts I and II and to cover a course in preparation for Part III of the Examination. An alternative arrangement which may appeal to some employers is to grant part-time day-release for four years, and to candidates who have obtained exemption from Parts I and II, with the exception of Engineering Physics (or Thermodynamics), to grant a further six months' full-time release for a course in preparation for Part III. This arrangement would have the merit of allowing students to attend their Part III courses at one of the major colleges, if their local college happened to be one in Category C.

Alternative Routes to Exemption

In conclusion, we stress that each route for achieving the professional qualification has been mapped to ensure that the resulting graduate engineers are of approximately equal standards of education. Differences there will be in outlook, in experience, in theoretical and practical abilities, resulting from not only the men themselves, but also the routes of qualification that they have followed; but all of these graduate electrical engineers will have a balanced scientific and technological education behind them. The professional differences between engineers carrying out similar duties should, if they have been trained aright, diminish as they grow older.

A picture of the various routes of qualification is shown in the table below. The university student leaving school at about 18 will follow a three-year full-time course leading to a degree in electrical engineering, followed by two years' graduate training. The student apprentice who undertakes an industry-based sandwich diploma course, leaving school at 17 after taking the General Certificate of Education at Ordinary level, will follow a five-year sandwich course; or if he leaves at 18, after reaching the Advanced level, he will follow the four-year sandwich course covering both education and practical training requirements. Part-time students on the other hand, will start at 16 or 17 years of age and if they are attending day-time classes they will take a total of six years. There is still a part-time evening route, but it is probable that this will be followed only by those who are late developers and whose potentialities cannot be foreseen in the early part of their courses. On the assumption that such a student enters the National Certificate course for the S.1 year at the age of 16, a total of eight years' evening study would be necessary to cover the whole of the exemption courses and the course in preparation for Part III. Such an educational struggle should obviously be avoided and it is hoped that employers will not force men to adopt this method. It is the policy of the Council, however, that the route shall not be blocked. Good engineers have achieved their professional qualification by it in the past, and the Council are agreed that the route should remain open to those who have the determination to follow it and for whom it is the only way.

Typical Age	National Certificates		Industry-based Sandwich Diploma	University or Full-time Diploma
	Part-time Evening	Part-time Day		
17	S.2 and Engineering Drawing	S.2 and Engineering Drawing	Pre-entry course	—
18	S.3	S.3 + OE	First Year	First Year
19	A.1	A.1 + OE	Second Year	Second Year
20	A.2	A.2 + OE	Third Year	Third Year
21	Endorsements	*Engineering Physics and Part III, Electrical Engineering	Fourth Year	Practical Training
22	(National Service)	(National Service)	(National Service)	Practical Training
23	(National Service)	(National Service)	(National Service)	(National Service)
24	*Engineering Physics and Part III, Electrical Engineering	Part III, Two special subjects (Evening)	—	(National Service)
25	Part III, Two special subjects	—	—	—

Notes: OE Subjects which may be optional in the course for, or offered as endorsements to, an Ordinary or Higher National Certificate in Electrical Engineering.

* A more intensive part-time day course or one arranged on the block release system would enable the whole of Part III, and the Engineering Physics or Thermodynamics of Part II (if not already covered), to be completed in the one year.

Journal I.E.E., December 1955

TOWARDS NEW POWER STATIONS

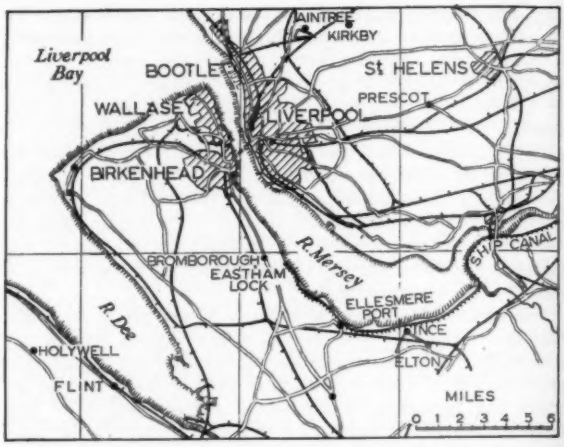
The Semi-Outdoor Concept at Ince

Since the war the Central Electricity Authority has often been castigated (and equally often praised) for building its power stations like cathedrals—lofty brick-built halls with clean architectural dignity, but perhaps not quite in keeping with pure functionality and a comparatively brief life. Thus considerable interest was aroused by the Authority's decision to build a semi-outdoor station, and this article describes some facets of the first of these projects, now more than half completed.

IN the southern United States, where the weather is usually hot and dry for most of the time, power-station designers sometimes wondered why they bothered to erect large buildings to house their equipment. After all, there were many industrial plants, especially in the oil refineries, which operated in complete exposure, even in northern latitudes. So they built an outdoor generating station, with only the amenity block and control room enclosed; and they liked the result.

But power engineers are by nature cautious—they have to be, for their failures could be very costly—and the fully outdoor station had but a limited appeal. On the other hand, it was soon conceded that most of the boiler-work could well be exposed, even if the turbo-alternators were under cover. So they began building semi-outdoor stations, and claimed that they could build them faster and cheaper than conventional ones. The concept was well received and the idea spread, until semi-outdoor stations reached as far north as New England, where the winters are long and the snow normally lies deep from November to March.

When the British electricity supply team visited some of these projects, under the auspices of the Anglo-American Council on Productivity, they were deeply interested by the claims made for the concept in respect of shorter construction times, lower costs and easier maintenance. However, precise figures were difficult to secure, even when a pair of stations, one orthodox and one semi-outdoor, but in other respects identical, were built within 12 miles of each other, for at both stations the schedules were disrupted by strikes. Nevertheless, savings of up to $5 per kilowatt of installed capacity seemed likely to be made, while from the British point of view the reductions in steel and brick requirements were pertinent commendations.



1 *The Mersey basin*

The Beginning at Ince

Coincident with the visit of this team to America there arose the need for a new power station in the Wirral peninsula, and upon the return of the team it was suggested that this station should be made a full-scale experiment in semi-outdoor construction, particularly as an acute shortage of steel and bricks then existed. After discussions between the Authority, various Ministries and architectural authorities, sanction was given to proceed with the proposition.

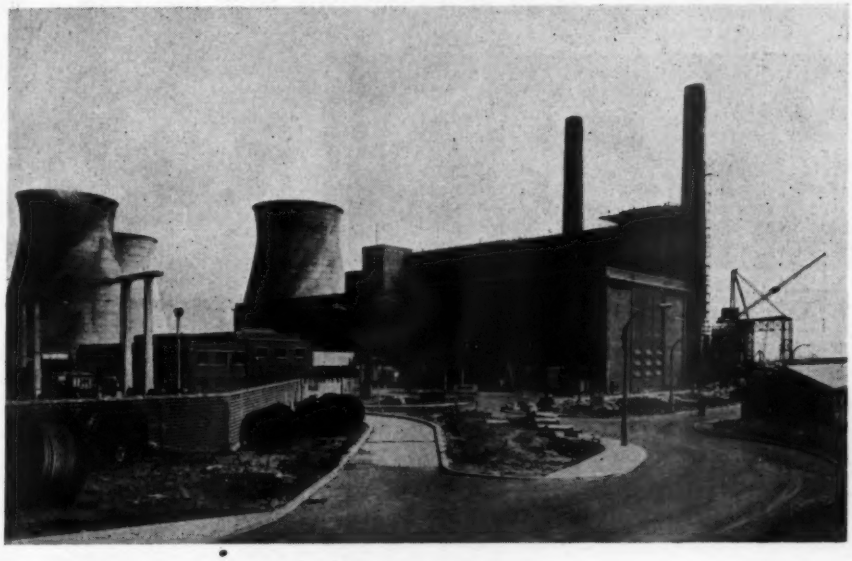
For various reasons it was considered essential that the proposed power station should be located in a very restricted area of the Wirral peninsula. The main difficulty was to find a suitable and sufficient supply of cooling-tower circulating water, and detailed investigation thus tended to favour a site on the north bank of the River Dee, but this was unacceptable to British Railways from the coal-supply aspect. The final choice was a site on the Frodsham Marshes close to the hamlet of Elton and lying approximately a mile from the River Mersey and the Manchester Ship Canal (Fig. 1). On the face of things this was a reasonable choice, particularly as rail access was good and the land was only partially cultivated. The main drawback was that the majority of the district consisted of a shallow layer of top-soil covering the builder's nightmare, silt and peat —this is not an uncommon thing in drained marsh-land—with the water table only a bare foot below the surface. However, close by the railway there is an area where, within a few feet of the surface, lies a ridge of hard bound sand and sandstone which is firm enough to carry a station of the size envisaged. The main buildings and plant have been constructed in this area.

The site having been agreed upon by the main parties concerned, the Authority initiated the process of obtaining the necessary Statutory Consents, without which construction could not be commenced, and the design of the station was begun. A brief survey of some of the

features of the design, as it grew from preliminary sketches and calculations to the final detail drawings and accurate data, were given to The Institution in a paper* by the designer, Mr. F. H. S. Brown, read before the Supply Section on the 16th December, 1953, a year before the first set was commissioned.

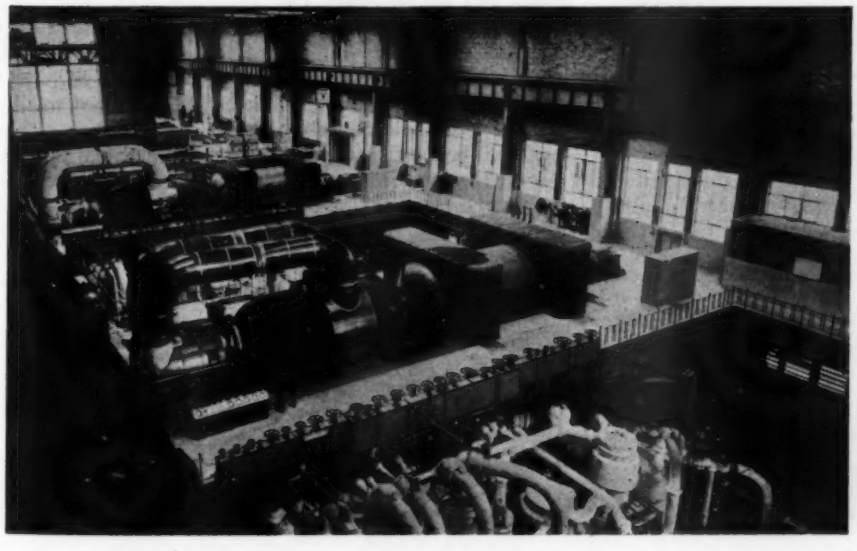
It seems strange that a station built adjacent to ground so wet that it is almost awash, virtually on the banks of a great river and a major canal, should have cooling-water problems. In the first place, the River Mersey was ruled out by the difficulty in obtaining the full quantity of water at all states of the tide from the shallow, sandy basin which forms the upper estuary, and then the Ship Canal was ruled out because the canal company was unable to supply water in the quantity required. In the end the engineers decided to participate in a scheme being promoted by various water authorities for extracting water from the River Dee at Chester for industrial and domestic supplies, and to install full cooling-tower capacity; this would ensure that the station could continue operation for several hours in the event of a water-supply failure—as indeed has happened. The length of the pipeline from Chester to the site is some 8½ miles.

* BROWN, F. H. S.: "Some Design Features of the Semi-Outdoor Power Station at Ince," *Proceedings I.E.E.*, Paper No. 1589 S, December, 1953 (see 101, Part II, p. 103).



2 *The station as seen from the west access road*

3 *The turbine hall, showing Nos. 1 and 2 sets*



Construction Begins

By the 4th April, 1951, the Statutory Consents had been obtained and 85 acres of land had been purchased. The first sod was cut by Mr. F. H. S. Brown on the 23rd of that month and work was begun. The first job was to clear the site and carry out formation work for the new railway sidings, and then to construct an access road including a prestressed reinforced concrete bridge over the railway to give approach to the site through Elton. Work was also begun on the secondary access road intended for heavy traffic, since the proposal to pump the ash to local settlement areas and then re-soil them had met with opposition, and the ash disposal had to be by lorry to more remote areas.

Foundations for the initial steelwork were ready in the summer of 1952, but it was not until the November that erection of the steelwork actually began. The delay was due to the acute shortage of steel, although Ince had a high priority; and here the semi-outdoor concept paid dividends; for had the design been orthodox, and so required

more steel, it is very doubtful whether the station could have been commissioned within striking distance of the scheduled date. In spite of this delay, boiler erection started when only 400 tons of steelwork had been erected, with temporary bracing to give rigidity during boiler-drum erection.

The steelwork delays were naturally reflected in the building-work programme, and the position was aggravated by labour troubles. Nevertheless, sufficient of the turbine room was completed in time to receive the first turbo-alternator set, although the building was not by any means weatherproof. In fact, the conditions throughout the first winter were arduous and great credit is due to the Station Superintendent, his staff, the contractors and the Divisional Construction engineers for triumphing over long hours of work and unfavourable conditions to achieve commissioning within a month or two of schedule. No. 1 set went into service on the 23rd November, 1954, and No. 2 set on the 26th March, 1955; No. 3 set is due to begin service in December, 1955, and the final set during the latter half of 1956, but such is the vigour and enthusiasm of all concerned that the latter date may well be anticipated.

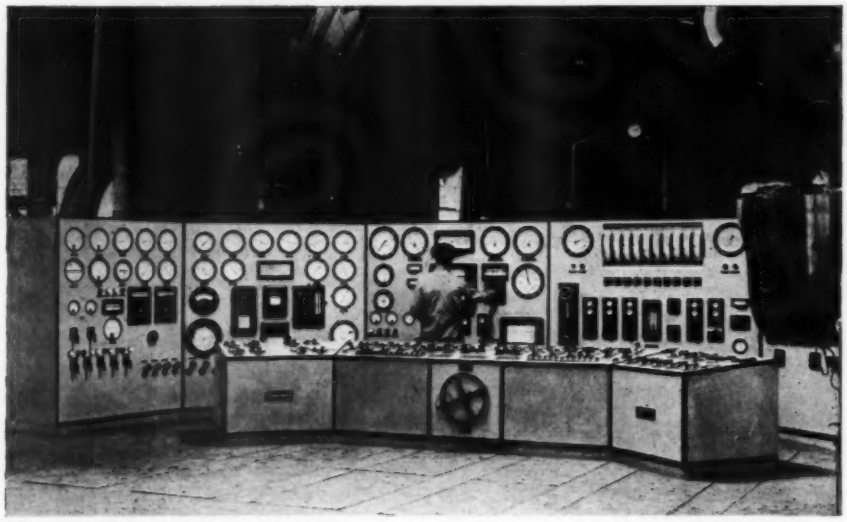
So with the station now half complete it is possible to make a first appraisal, although full judgment must naturally be reserved until the whole station has been steaming for several months. Nevertheless, Ince has been feeding energy into the Grid for some time, and up to the 19th November, 1955, has steamed 6180h and generated 455016MWh; a pattern is beginning to emerge.

Impressions at Ince

First impressions are often quite useful, and a first impression of Ince can be gained on a clear day from the main Crewe–Liverpool railway line. As the train crosses the edge of the Frodsham Marshes Ince appears as a squat mass of building and cooling towers, topped off by its two tall chimneys and dominated by the great flat expanse of pasture land on which it stands. It looks, and is, remote.

The next view comes as one drives down the west access road, across the new bridge over the Hooton–Helsby railway line, and sees the power station at close quarters (Fig. 2). From here it looks like an orthodox red-brick station, except that the turbine hall is perhaps rather lower than customary, because the basement floor is constructed directly on the hard bound sand some 14ft below ground level. The access road curves down between the 132kV switching compound and the neat, functional administration block. Now complete, this has an air of cool, quiet efficiency, yet nothing has been forgotten in the struggle to give the staff the amenities which are so necessary for round-the-clock working. From the upper floor an enclosed bridge gives all-weather access to the turbine hall at operating-floor level, and it is here that an impression of the unusual is gained. For a 240MW station based on four units it is indeed small. Much space has obviously been saved by dropping the roof well below the tops of the boilers, although in this respect the proportions are admirable. More space has been saved by providing doors in the wall for rotor withdrawal (clearly seen in Fig. 3), instead of quite vast expanses of otherwise wasted space; after all, the diameter of a rotor is very small compared with the length of a turbine hall, and rotor withdrawal is hardly a frequent practice. At basement level, however, one feels that this space reduction might perhaps have been carried a little too far, for here there is a complex of auxiliaries. Only experience will show whether these fears are justified.

On the operating floor, the whole concept is neatly planned, from the exciters to the four great control consoles (Fig. 4), one for each unit, from which one man



4 *One of the unit control consoles*

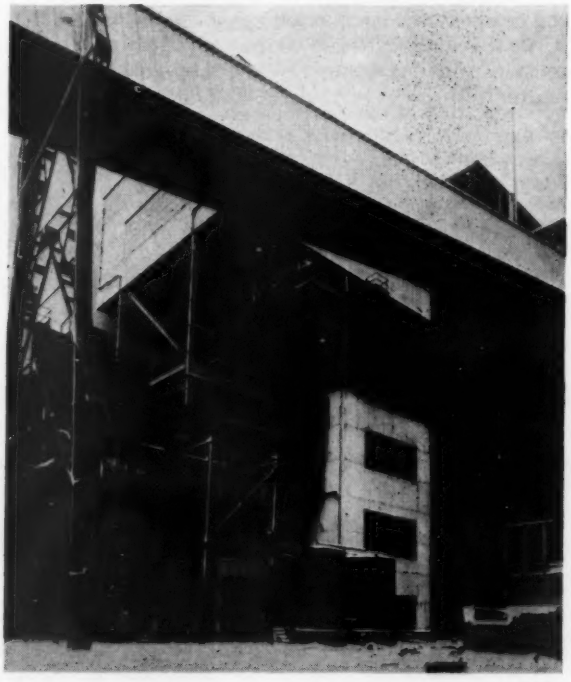
5 *In the open galleries during midwinter*

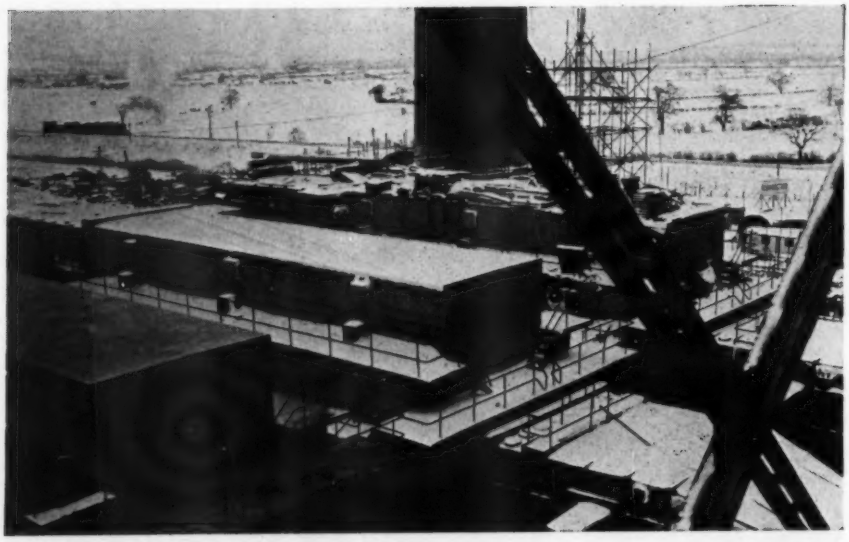
can, if need be, control the entire unit—boiler, turbine and alternator. Walking past the control consoles into the firing face of the boiler area is like walking through any orthodox station, and it is not until one has climbed the galleries through the boiler framework and emerged at the very back of the station below drum level that the semi-outdoor features become apparent. Yet such is the protection afforded by the cladding at drum level, together with the lee created by the great bulk of the precipitators, that it is quite possible to stand on the open passageways in the driving rain without getting wet. Figs. 5 and 6, photographed after a snowstorm, show just how little snow penetrated these upper galleries, while Fig. 7 shows for comparison the amounts which lay on the surrounding countryside and the inoperative precipitators (that on the extreme left was working). Small wonder, perhaps, that the staff have coined the term "demi-semi-outdoor" for the concept.

For the station to be appreciated fully it should be viewed from the coaling area, for here the full effect of the designer's ideas is apparent. Where in an orthodox station there would be hundreds of square feet of brickwork, one sees at Ince only the somewhat gaunt array of steel girders (Fig. 6) reaching up to the cladding at drum level. Fig. 8 was photographed, in summer, from the junction tower; from this side of the station the eye is constantly drawn upward to drum level, by the chimneys, by the steelwork and by the coal conveyors, a long tunnel of cladding running along the storage area, climbing steadily to the top of the junction tower, then rising again from its foot to bunker level—a rising line of silver. The erection time and labour costs saved by this cladding are obvious, and its composition—compressed asbestos fibres with a steel core—has much to commend it, for it is both light and fireproof; but it does look so much like corrugated-iron sheeting, perhaps because of its dull aluminium finish, that it contrasts a little oddly with the pleasant vista of the front of the station. None the less, it is eminently practical.

The coal-handling arrangements reflect the latest developments in the field, with a carefully laid out system of sidings, tipplers and delivery belts. It is quite fascinating to watch the two men handle up to 15 laden

6 *A "somewhat gaunt array of steel girders reaching up . . ."*
No. 1 boiler and the north tower.





7 *Precipitators and the Frodsham Marshes, under snow*

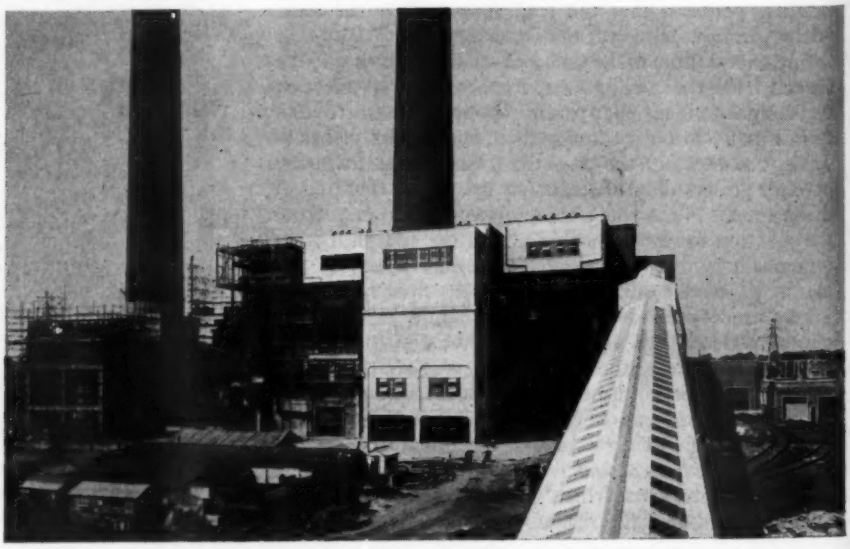
trucks on to a tippler without a locomotive; a chain-hauled truck-like device called the "beetle" draws the trucks to the tippler; each truck is then turned over, so that its cargo cascades down a chute onto a system of endless belts, which finally deliver it to the bunkers.

Ince at the moment is a pulverized-fuel-fired station, the coal in the main coming from the East Midlands pits by rail via Buxton, but the boilers are about to be changed over to oil firing and must afterwards be able to reconvert to coal firing with the minimum of delay. The oil will come from an adjacent refinery, from which it will be pumped over the intervening two miles.

Back in the station itself there is much to be commended, and such things as the intelligent use of bled steam for space warming in the administration and welfare block, and the generous distribution of space to dispel possible feelings of claustrophobia in the main control room, are but small examples of the foresight and experience which have gone into this design.

It is far too soon for sweeping generalizations, but such experience as they have had leads the operating staff to believe that Ince will be no more difficult to operate than an orthodox station, while maintenance, especially in the boiler area, may be easier.

For a climate as difficult as ours it is quite an experiment, and like all experimental constructions—especially in the half-complete state—it is not perfect. But it is a bold step forward towards new power stations which gives the lie to those who say that our national supply authority lacks ingenuity, drive and courage.



8 *The station as seen from the coal storage area, with construction well past the half-way mark*

Jackson of the "Defiance"

by ALAN T. RAWLES, Royal Naval Scientific Service

Admiral of the Fleet Sir Henry Jackson held many appointments of national importance during his lifetime, but his fame may yet come to rest mainly on his early inspired work on wireless telegraphy, which he carried out aboard H.M.S. "Defiance." But for the restrictions imposed on him by the naval life of those days Jackson might well have challenged Marconi in the invention of radio. This article first appeared in a naval journal of limited circulation and a slightly shorter version of it is printed here by kind permission of the editor.

Captain H. B. Jackson in 1897

THE career of Henry Bradwardine Jackson was, in some respects, a paradox. The picture that one conjures of him from the literature of his time is of a shy, retiring and rather nervous man—an image that ill accords with that of a man who held most of the important Admiralty appointments at one time or another, and who attained the highest rank that the Royal Navy can offer. It is hardly too much to say that he achieved greatness unwillingly for it is certain that he cared little for the *succès d'estime* that attended his position. What meant more to him than all these honours was his association with the development of radio from the earliest days.

From 1895, when as Captain of the *Defiance* he demonstrated naval wireless communication for the first time, until his death in 1929 he held a unique position among the pioneers of the craft. It is true that the view held by the writer that Jackson invented wireless telegraphy is not generally accepted; but few would deny that his contribution to the science was of the greatest value. It is as "Jackson of the *Defiance*" that he will be remembered and that is as he would wish.

Early Concepts

Henry Jackson, a farmer's son, was born at Barnsley in 1855. He chose a naval career although his family had no strong connection with the sea and he joined the service just before his 14th birthday. With his Daedalian mind it is not surprising that he asked to be allowed to qualify in the torpedo branch, which was then the only branch of the Navy that afforded opportunity for scientific research. At first his career followed a normal pattern and it was not until 1890 when he was appointed to *Vernon* that it becomes of unusual interest.

A task which then confronted *Vernon* was that of designing a device by which friendly torpedo boats might give warning of their approach to their parent ship. The possibility of using the newly discovered Hertzian waves immediately occurred to Jackson; they were then regarded merely as a scientific curiosity—a practical demonstration of Maxwell's theory—and no useful application of them was known or envisaged. Since, however, at that time no means of readily detecting the presence of these waves was known, Jackson was forced to put the problem on one side and it was not for five years that he was able to make any progress.

The First Transmission of Signals

In 1895 he had read of the work on coherer detectors by Sir Jagadis Bose and at once saw the old problem was now capable of solution. By now he was in command of the torpedo training ship *Defiance* at Devonport and it was on board this ship that his experiments were carried out. They culminated one day in August when he succeeded in sending Morse signals from one end of the ship to the other.

The apparatus used by Jackson was naturally of a primitive nature. After detection by a coherer which Jackson made himself, the received signal operated a relay which in turn actuated an electric bell. The ringing of the bell without the agency of any external wiring heralded a new epoch—the radio age.

The report of the *Defiance* experiment seems to have been lost on the Admiralty, who appear to have made no attempt to patent Jackson's method. The consequences of this omission can hardly be exaggerated for in the following year an historic application was lodged at the Patent Office. It was in the name of Guglielmo Marconi.

Meeting with Marconi

The anti-climax caused by this somewhat lukewarm reaction left Jackson undismayed. He continued his experiments and in 1896—newly promoted Captain—he received signals over a distance of several hundred yards by the use of a larger spark and a more efficient coherer. By this time, after much advance publicity, Marconi arrived in England and was introduced to Jackson at a conference at the War Office. This oddly contrasted pair, the young Italian with all the flamboyance of his race and the taciturn Englishman, had in

common a great belief in the future of their invention. Though regarded as rivals (as in a sense they were) this bond was the basis of a friendship which lasted until Jackson's death. Each had previously been unaware of the other's work; now most secrets were shared and neither ever abused the trust placed in the other. Jackson was now able to persuade the Admiralty that further experiments would be of value; they authorized him to continue them and allocated some money for the purpose. He was, unfortunately, unable to fully avail himself of this opportunity since he was appointed in the following year as Naval Attaché in Paris, where such research was almost impossible.

Naval Restrictions

Whether or not Jackson would have seriously challenged Marconi in this field will never be known. The Italian had several advantages: he was untrammelled by the restrictions imposed by a service career and had a small band of trained assistants to help him. Marconi and Jackson were popularly regarded as competitors in a sort of race to produce a workable wireless-telegraphy system. But, in truth, if we are to pursue this analogy, Jackson was clearly a non-starter. In Paris he could do nothing except give advice to his successor in *Defiance* (Captain Hamilton) who was continuing the experiments in a rather desultory fashion and with little success. Jackson's loyalty and devotion to duty were unquestioned but, even so, his chagrin at being taken from his work in *Defiance* could not be altogether concealed.

"I was naturally very disappointed," he wrote to Marconi, "at having to leave off my experiments when they were in a very interesting stage and at a time when probably my personal supervision was most required as, at the time, everyone seemed against the system except you and I."

Typically, however, he was able to refer to this, one of the greatest disappointments of his life as "one of the little things one has to put up with in our service."

During Jackson's absence from England Marconi's demonstrations became almost weekly more ambitious. Jackson realized more than anyone else that he would no longer be able to compete with his friend and the gracious way in which he acknowledged defeat is typical of his disposition.

"Accept my congratulations on your recent successes," he wrote, "which have evidently surpassed those of any other experimenters on the subject, including myself."

Conversion of the Admiralty

Jackson cared not at all that the prestige and honour which so easily might have been his would now devolve on Marconi; his one concern was that the Navy should enjoy the advantages of wireless as soon as possible. Accordingly he devoted his energies to trying to persuade the Admiralty that Marconi's equipment was worth a trial. The Admiralty, however, put forward a number of objections to this proposal, one of which was a report by the Signal Committee "against the use of wireless for fear that it would blow up the ship's magazine." This observation was not altogether unreasonable at a time when little was known about the new invention, but it was unfortunate in that it further increased the unwillingness of the Admiralty to try the equipment.

That in 1899 the Admiralty at last changed their minds was due almost entirely to Jackson's persistence; they agreed to let Marconi fit his equipment in four ships for the manoeuvres of that year. Jackson was home by now and in command of *Juno* which—he made sure—was one of the four ships selected for the trials. The trials were astonishingly successful, ranges of 60–70 miles were regularly obtained and the commander of the victorious force, Admiral Domville, attributed his success largely to the use of wireless which he said, with obvious wonderment, "was equally efficient in all weathers."

The doubts which the Admiralty had entertained were now removed and a contract was placed with the Marconi Company for 32 sets. Indeed so enthusiastically did the Admiralty now take up wireless telegraphy that we find Jackson, of all people, complaining in a letter to Marconi "that it was being done so hurriedly that we suffer from a want of skilled operators."

A Clash of Opinions

Under Jackson's guidance the development of the naval wireless service now proceeded rapidly, although at first the Admiralty were very reluctant to pay the royalty of £100 per installation which was asked by the Marconi Company.

Indeed expert advice was sought to determine whether an action to dispute the validity of the Marconi patents would be likely to succeed. Sir Oliver Lodge was asked for his opinion and in his report he pointed out that on 1st June, 1894—a year before the *Defiance* demonstration—he had performed a very similar experiment. He implicitly accused Jackson and Marconi of copying his work, a charge that Jackson refuted with unusual heat:

"At the time I first commenced my experiments in 1895 I had not heard of Lodge's experiments and I had not read any of his works nor any of those mentioned by him and though I have since studied some of them and have learnt therefrom much of the phenomena connected with wireless telegraphy, I certainly have not learnt anything of any practical use from any of them."

With no less vigour Jackson defended his erstwhile rival Marconi from the charge of plagiarism. Describing Lodge's report as "extremely egotistical and biased" he pointed out that Marconi had begun his work in an Italian village where "Dr. Lodge's work and name were less well known than he thinks possible."

Jackson was convinced that Marconi was fully entitled to profit by his invention and it was partly a result of his attitude that the Admiralty came to a mutually satisfactory arrangement with the Marconi Company.

This controversy is of interest in that it seems to be the only occasion on which Jackson took part in the dispute over priorities. The fact that Lodge's experiment took place a year before Jackson's does not, the present writer believes, deprive Jackson of his place as the father of wireless telegraphy. Lodge's case is spoiled by his admission that he "did not pursue the matter into telegraphic applications as he was unaware that there would be any demand for this kind of telegraphy." Because Jackson did immediately see just such a demand and as Marconi's first successful transmission did not take place until December, 1895, Jackson's precedence would seem to be indisputable.

Development Work

Jackson, who was from 1899 generally responsible for wireless development in the Navy, delighted in his new work. From the torpedo depot ship *Vulcan*, of which he was in command on the Mediterranean station, he reported frequently and enthusiastically both to the Admiralty and to Marconi. His researches were directed mainly to extracting the greatest possible efficiency from the equipment by careful tuning.

He also carried out an exhaustive study of the screening effect of land and of the interference caused by atmospherics which he embodied in his famous paper read to the Royal Society in 1902 to which he had been elected in the previous year.

In the years leading to the First World War Jackson's reputation steadily increased. From 1905 to 1908 he served as Third Sea Lord and during this appointment he was promoted to Flag rank and was knighted. His appointment as Commander of the Sixth Cruiser Squadron in the Mediterranean was followed by a two-year term in charge of the newly created Royal Naval War College.

First Sea Lord

The outbreak of war in August, 1914, marked the beginning of a new phase in Jackson's career. He held a succession of appointments at the Admiralty which brought him from comparative obscurity to the scrutiny of the public gaze. When in the following year, the First Sea Lord, Lord Fisher, resigned in somewhat sensational circumstances, Jackson succeeded him. The appointment was everywhere well received. It was a time of the gravest anxiety: losses due to submarine warfare increased week by week and it was widely felt that Jackson with his scientific background and even temperament was well suited to fill this key post. It is sad to record that these hopes were ill-founded.

The U-boat campaign claimed more and more victims and Jackson's rooted objection to the convoy system must have been at least a contributory factor to this state of affairs. Dissatisfaction in the country at the way in which the war at sea was being waged found expression in the correspondence columns of *The Times* and was brought to a peak when that most influential newspaper strongly criticized Jackson's direction in a leading article.

The Prime Minister, Mr. Asquith, could no longer ignore the clamour of public opinion and pressure from within the Cabinet, and so Jackson was swept from the public scene by a wave that engulfed not only him but the First Lord and the Prime Minister himself. That Sir Henry bore no ill-feeling is evident from the obviously sincere letter of good wishes which he wrote to Jellicoe, his successor. Possibly he was not sorry to relinquish an office for which he was temperamentally unsuited.

One event in this somewhat unhappy episode of Jackson's career gave him great satisfaction. He revealed after the War that the Royal Navy was able to engage the German fleet at the battle of Jutland because of information received from Naval direction-finding stations. They reported that a change in bearing of signals intercepted from some of the German ships indicated the fleet had left their moorings at Wilhelmshaven and were moving down the Jade river to the sea. This forewarning proved of the greatest value to the Royal Navy, which was thereby able to meet the enemy in favourable waters. Nothing could have vindicated Jackson's belief in the value of wireless more than this.

The Last Years

Jackson retired to the more peaceful scene of the Royal Naval College, Greenwich, where he remained as President until his promotion to Admiral of the Fleet in 1919.

In 1920 he was appointed First Chairman of the Radio Research Board of the Department of Scientific and Industrial Research and under his supervision research of the greatest importance was carried out for which he, characteristically, disclaimed all credit. He was a familiar and well-loved figure at meetings and conventions and did much useful experimental work at his home mainly in the field of short-wave propagation. An event that took place about this time which gave him much pleasure, was the award in 1926 of the Hughes medal of the Royal Society.

In 1929 he moved to Saltern's House, Hayling Island, and on the 14th December of that year he died at the age of 74. His grave may be seen in St. Mary's Churchyard, South Hayling.

In the twenty-five years that have passed since Jackson's death the science of radio has made strides so great that we are perhaps inclined to overlook the remarkable achievements of the pioneers of the craft who persevered in the face of prejudice and opposition.

Acknowledgments

My thanks are due to Marconi's Wireless Telegraph Co. for allowing me access to correspondence in the Company's archives; to the staff at the Admiralty Library and to Mr. McLoughlin of the A.S.R.E. Library, for their cheerful and invaluable assistance.

CORRESPONDENCE

THE GRAHAM CLARK LECTURE

From S. E. GIESZCZYKIEWICZ, DIPL.ING., MEMBER

In the Graham Clark lecture, "The Engineer's Contribution to the Conservation of Natural Resources," delivered by Sir Harold Hartley, and published in the September *Journal*, it is stated that a power station on the Kabul River at Warsak would provide 60 000 kW of power. This is not quite correct.

It has been decided to build the power station at Warsak to have an ultimate capacity of 240 000 kW in six units—an average of 240 000 kW will be available for 24 hours a day for approximately four months in each year.

The first stage is now under construction. The enterprise is financed jointly by the Governments of Pakistan and Canada, under the Colombo Plan. Four units will be installed, each rated at 40 000 kW with provision for an addition of two further units in the future. The total estimated cost of the first stage is approximately $40 000 000.

The minimum 24-hour power may drop during a few days in winter to 60 000 kW, but as a pondage reservoir will be provided, with sufficient capacity for a diurnal regulation, it will be possible to operate the Warsak station as a peak-power station up to the maximum installed capacity, if required.

[Sir Harold Hartley has seen this letter. He agrees that the information given him about the Warsak plant was not quite correct, and thanks Mr. Gieszczykiewicz for setting out the facts.—*Editor.*]

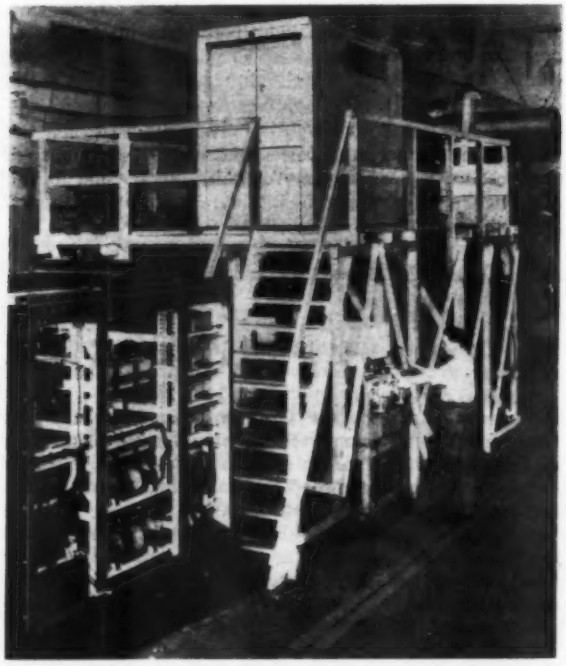
Mr. S. E. Gieszczykiewicz is with H. G. Acres and Co., Ontario, Canada.

DIGESTS *of Papers in the Proceedings*

A High-Power Mechanical Contact Rectifier

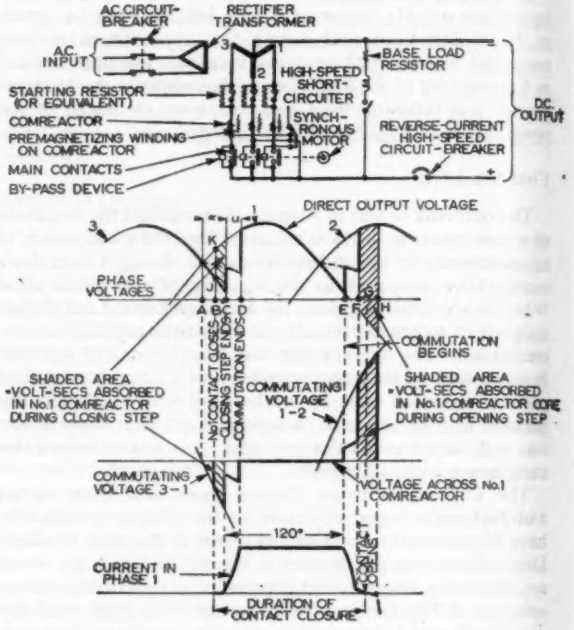
A digest of a Utilization Section Paper (No. 1939) with the above title, by J. C. Read, D.Sc., Member, and C. F. Gimson. The full paper was published in October, 1955, in Part A of the Proceedings.

THE HIGH-POWER MECHANICAL CONTACT RECTIFIER WAS first developed in Germany before and during the 1939–45 War, and during the past five years it has been receiving renewed attention in several parts of the world. Its great advantage is its very high overall efficiency, which renders it specially attractive for steady loads such as those encountered in the electrochemical industry. In 1950 the development of a new design of mechanical contact rectifier, for a rating of 15000 amp at about 250 volts, was undertaken in this country, and after successful trials on a full-size prototype ten further sets (one of which is shown in Fig. 1) were constructed, having closely similar ratings and design-particulars. Details of these sets are described in the paper, with special reference to departures from previously established practice.



1 *One of the 1955 rectifiers on works test*

The mechanical unit is seen mounted above the comreactors, with the transformer in the background. The framework on the left is the premagnetization cubicle.



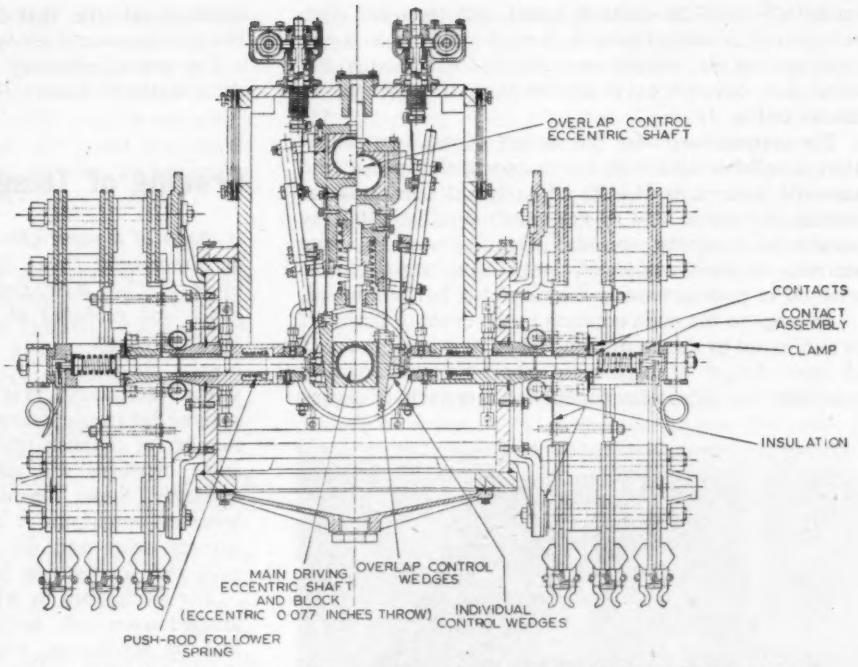
2 *Elementary connections and operation of a simplified contact rectifier*

The operating principle of such rectifiers is summarized in Fig. 2. Rectification is effected by the synchronous closing and opening of small contacts at the appropriate instants in the cycle, aided by special commutating reactors, or *comreactors*, in series, which create low-current steps in the wave at the instants of contact-closing and contact-opening. By suitably premagnetizing these comreactors, and by the use of by-pass circuits in parallel with the contacts, the current and voltage broken are reduced to such low values that the contacts operate sparklessly and with long life, although each contact has to carry as much as 7500 amp during its conducting period in each cycle.

The mechanical unit as developed has twelve such contacts, arranged six on each side of a horizontal main operating shaft which is driven by a synchronous motor. Each contact is pushed open by a push-rod acting against a powerful spring, each assembly of fixed and moving contacts (which are solid silver) and spring being quickly removable for ease of replacement. Each opposite pair of contacts is actuated by a common eccentric on the main shaft. The construction is shown in Fig. 3. Unlike most previous designs, the push-rods are operated by a crosshead provided with spring suspension. This avoids a number of pivoted joints and results in true simple harmonic motion, and this in turn

reduces the wear on the needle roller bearings arising from slipping caused by changes in speed. Adjustment of the contact timing is effected by a double set of wedges, one giving individual adjustment for each contact and the other giving common adjustment of all contacts simultaneously.

Forced oil lubrication is provided at two pressures, a low-pressure system for the needle roller bearings and a high-pressure system for the overlap-control wedge mechanism. In addition a vacuum scavenge-pump system prevents oil from leaking out through the pushrod guides. The contacts and heavy-current connections are cooled by forced filtered air. The complete mechanical unit is constructed with vertical plug-in contacts for ease of removal and maintenance, and is enclosed in a cubicle lined with sound-absorbing material.

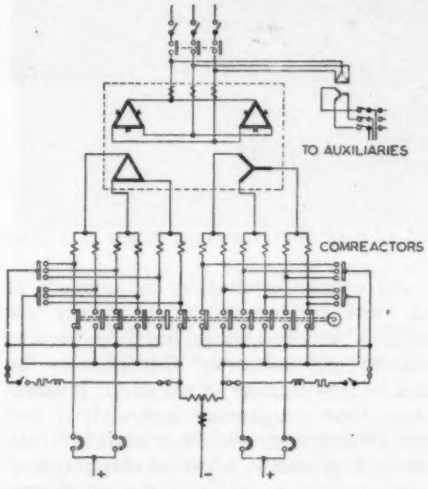


3 *Sectional view of one phase-assembly with its relationship to actuating contacts*

The system of connections adopted consists of two 3-phase bridges, displaced 30° apart so as to give 12-phase waveforms. There is a separate comreactor in series with each contact, instead of one in series with each pair of opposite contacts, careful study having shown that this is economical in cost and gives important operating advantages which result from the longer interval between successive conducting periods in the cycle. The resulting main connections are shown in Fig. 4.

One of the important advantages of this choice of connection is that phase control of voltage can be obtained by varying the length of the closing step instead of by mechanical means, and thus the contact can close always when there is practically no voltage across it, thereby eliminating sparking at closure. For this purpose a new method of controlling the contact timing has been adopted, in which the control shaft which actuates the common set of wedges is coupled by means of a cam to a mechanism which shifts the driving motor stator. Consequently the instant of opening can be automatically varied as required to keep it within the opening step, while the instant of closure remains practically constant.

A contributory factor to this scheme is the by-pass devices used in parallel with the main contacts. These devices consist of a number of the newly-developed germanium power diodes, which reduce the recovery voltage that appears across the contact at opening to a much lower value than any by-pass arrangements previously used, and thus reduce sparking at opening. They also reduce sparking at closure, since the closing-step current flows initially through the by-pass circuit, and when the contact closes it short-circuits only the small voltage across the germanium diodes. Another feature is that the need for the series starting resistor shown in Fig. 2 disappears; instead the set can be switched



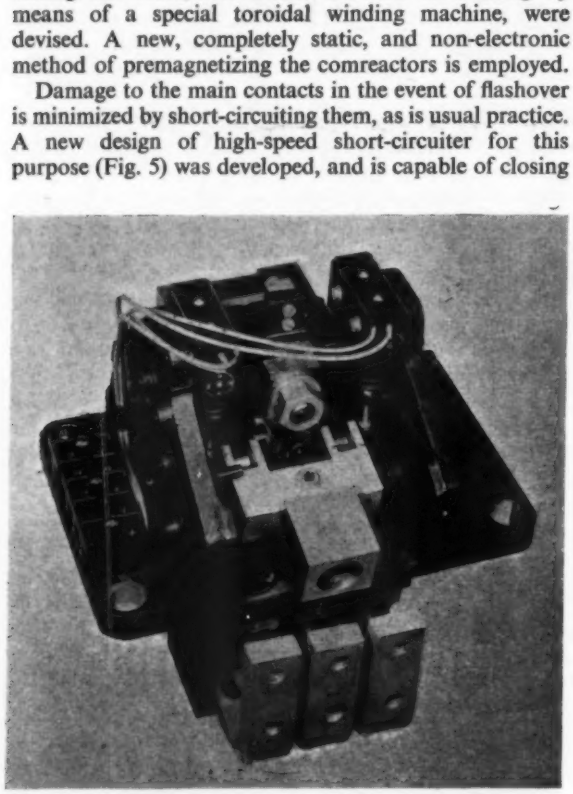
4 *Main connections of 15000amp 220–270-volt 12-phase contact rectifier*

Premagnetization and by-pass circuits, and tripping circuit for short-circuiters are not shown.

on initially with the contacts raised, and these can then be lowered without haste. A further result is that the auxiliary supply transformer can be fed through the same a.c. circuit-breaker as the main transformer, as shown in Fig. 4.

The comreactors were the subject of much investigation in collaboration with the makers of the special core material, known as H.C.R. alloy. Novel apparatus for testing the cores, and a new method of winding by means of a special toroidal winding machine, were devised. A new, completely static, and non-electronic method of premagnetizing the comreactors is employed.

Damage to the main contacts in the event of flashover is minimized by short-circuiting them, as is usual practice. A new design of high-speed short-circuiter for this purpose (Fig. 5) was developed, and is capable of closing



5 *High-speed short-circuiter*

a 3-phase circuit of over 50 000 amp per phase in a time of 1 millisec.

The current and voltage handled by the contacts at both make and break are reduced to abnormally low levels by the methods described above, but there remains a process of gradual "pip-and-crater" formation on the contact faces due to slow transfer of the silver. It seems to be best to keep these roughnesses accurately in line with one another. Experiments have been made in which the moving contact is guided by a special diaphragm of glass-impregnated material to maintain this alignment, and this construction appears to give further benefit.

At the time of writing the contact life reached has been a little over 2000 hours, and the appearance of the contacts indicates that their ultimate permissible life is likely to be several times longer.

The overall efficiency obtained, as determined by the usual methods, is over 97%.

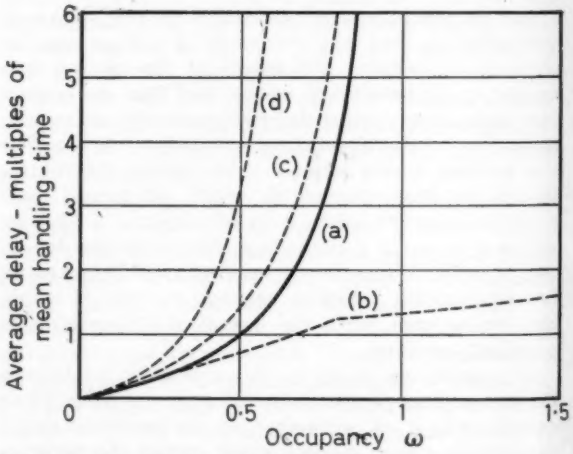
Grading of Telegraph Messages

A digest of a paper (No. 1916) entitled "Traffic Flow in an Exponential Delay System with Priority Categories," by R. E. Cox, B.Sc.(Eng.), Associate Member. The full paper was published in November, 1955, in Part B of the Proceedings.

WHEN TELEGRAPH TRAFFIC IS OFFERED IN A RANDOM manner for transmission through a system with a limited number of channels (circuits, operators or equipments), some messages will suffer delay until a free path is available. Some means of assessing these delays in specified conditions is essential, such quantities as the *average delay* and the *proportion of messages delayed more than a given time* being required.

The mechanism by which these delays occur has been studied extensively, both by the use of probability theory and by simulation, and is now well understood. In particular, the complete solution for the case where the histogram of the transit times of the messages is exponential in form was established by Erlang in 1917. These previous studies, however, appear to be confined to simple systems where the traffic is homogeneous, in the sense that each message has an equal right to be transmitted as soon as possible.

The paper is the outcome of a mathematical investigation into the effect of introducing priority gradings into an exponential system. The occupancy of a system is first defined as the proportion of the total available channel-time that is actually utilized in passing traffic,



Variation of average delay with occupancy

(*a*) Homogeneous traffic.
(*b*) Priority traffic.
(*c*) Remainder of original traffic.
(*d*) Additional deferred traffic.

and the definition is extended above unity in the interpretation that if the occupancy is ω where $\omega > 1$, $1/\omega$ of the total traffic would fully occupy the system. Expressions are then developed which describe the behaviour of messages in any priority category containing any fraction of the traffic. They are found to resemble in form the equivalent equations for homogeneous traffic if use is made of a quantity

$$\omega' = 1 - (1 - x\omega)(1 - y\omega)$$

where ω is the occupancy of the system, x is the proportion of total traffic in higher categories than the one being investigated, and y is the proportion of total traffic in both this one and higher categories. The expressions are shown to be valid for traffic in a priority category even when the total occupancy of the system exceeds unity (i.e. the system is completely choked with other traffic) provided ω' remains fractional; ω' is therefore termed the *equivalent occupancy* of the category defined by x and y. It reduces to ω when the traffic is homogeneous and hence $x = 0$ and $y = 1$.

As an example of the use of these equations, the Figure shows a comparison between the average delays expected on a single-channel exponential system, first with homogeneous traffic and secondly when 25% of the messages are given a priority over the rest and an additional 25% of deferred traffic is superimposed.

Radar Reflection

A digest of a Radio and Telecommunication Section paper (No. 1917) entitled "Determination of the Reflection Coefficient of the Sea, for Radar-Coverage Calculation, by an Optical Analogy Method," by G. W. G. Court, B.Sc., A.Inst.P., Associate Member. The full paper was published in November, 1955, in Part B of the Proceedings.

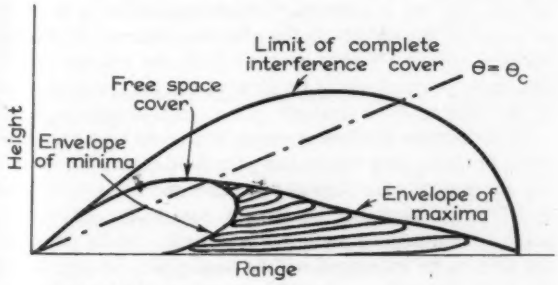
IN CALCULATIONS BASED ON VERTICAL-COVERAGE diagrams of a radar set operating over the sea, due account must be taken of the interference between rays reflected from the surface of the sea and direct rays from the aerial. For long wavelengths, specular reflection, and hence complete interference, can be assumed, whereas for very short wavelengths, non-specular reflection, and hence no interference, is generally assumed. To obtain some indication of the way in which the radio reflection coefficient may be dealt with for the intervening wavelength region, a simple optical analogy has been used. Measurements of the reflection of light by a matt surface provide an indication of the law governing change of the value of the reflection coefficient ρ (the ratio of reflected and incident intensities) with angle of elevation of the light ray. This information has been applied to the radar case for various radio wavelengths and different sea states. A critical angle θ_c is defined, above which no specular reflection occurs:

$$\theta_c = \frac{\lambda}{8h}$$

where λ is the radio wavelength, and h is the mean height of waves on the surface of the sea. The ratio, k,

2 *Reflection of an illuminated vertical slit, by ground glass surfaces*

The value of the critical angle θ_c is indicated by the length of the image and is appreciably greater for the finely ground surface on the left than for the coarser surface on the right.



1 *Modified polar diagram*

of the reflected and incident amplitudes of radio waves incident on the sea surface at angle of elevation θ is then given by:

$$k = \exp\left(\frac{a}{2} \cdot \frac{\theta}{\theta_c}\right)$$

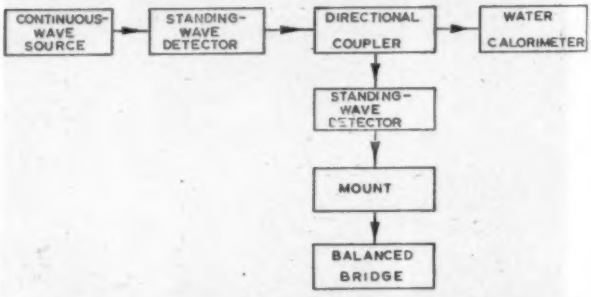
where a is an arbitrary constant.

The type of coverage diagram resulting from this treatment is shown in Fig. 1, and radar test-flight results do not conflict seriously with the coverage diagram calculated by the proposed method.

Measurement of Microwave Power

A digest of a Radio and Telecommunication Section paper (No. 1918) entitled "The Measurement of Power at a Wavelength of 3 cm by Thermistors and Bolometers," by J. A. Lane, M.Sc., Associate Member. The full paper was published in November, 1955, in Part B of the Proceedings.

METHODS OF MEASURING POWER AT CENTIMETRIC WAVE-lengths have been of fundamental importance since techniques for the efficient generation and reception at such wavelengths first became available. One convenient method in extensive use for powers from a few microwatts to a few milliwatts depends on the change of resistance

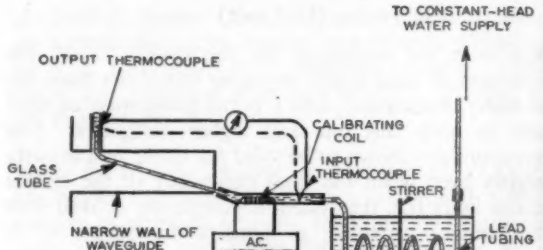


1 *Arrangement of apparatus for calibration of bolometer and thermistor mounts*

with temperature of small semi-conducting beads (thermistors) or fine wires (bolometers). These can be arranged in wave-guide transmission lines in such a way that most of the input power is absorbed in the resistive element. At wavelengths of 3 cm and below, however, a significant proportion is dissipated in metallic surfaces and dielectric material external to the thermistor bead or bolometer wire. Experiments to determine the error involved in a d.c. calibration of typical thermistors and platinum-wire bolometers when used at wavelengths of 3·18 cm and 3·26 cm are described in the paper.

The principle of the method used and details of the experimental equipment are shown in Figs. 1 and 2 respectively. Powers of a few watts from a continuous-wave magnetron were absorbed in a constant-flow water calorimeter considered as a reference standard. By use of an accurately calibrated directional coupler, these powers were compared with powers of the order of a milliwatt measured by the thermistor or bolometer in a d.c. bridge network. The water calorimeter consisted of a thin column of water contained in a Pyrex tube extending across the waveguide in a plane parallel to the broad face. The power absorbed was measured in terms of the equivalent low-frequency (50 c/s) power in an auxiliary heating coil. Thermal and radiation losses were reduced to a minimum and the error limits associated with the final calibration are thought to be $\pm 2\%$.

The power measured by the thermistors and bolo-



2 *Water calorimeter for power measurement at 3·2 cm*

meters was 9–11 % less than the true power for thermistor and bolometer resistances from 150 to 300 ohms. This discrepancy is somewhat higher than that previously observed by other workers and the results indicate the importance of an absolute calibration of power-measuring equipment at a wavelength of 3 cm.

Microwave-Field Measurement

A digest of a Radio and Telecommunication Section paper (No. 1921) entitled "A New Perturbation Method for Measuring Microwave Fields in Free Space," by Professor A. L. Cullen, Ph.D., Associate Member, and J. C. Parr, B.Sc. The full paper was published in November, 1955, in Part B of the Proceedings.

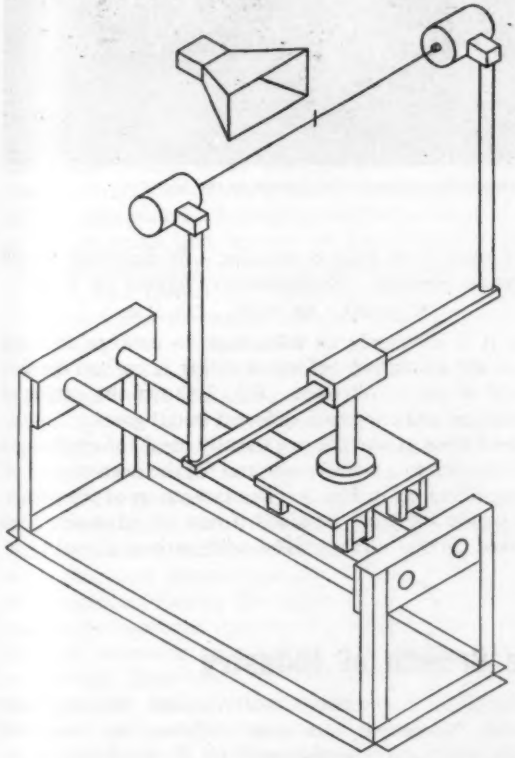
IT IS A WELL-KNOWN PRINCIPLE OF MEASUREMENT THAT the measuring instrument should not significantly alter the quantity being measured. Thus, in measuring a voltage, we use a voltmeter whose resistance is as high as possible in relation to the effective internal resistance between the two points across which the voltage exists. The same principle must be observed in the measurement of the electric field strength in an electromagnetic field.

In measuring the field strength produced by a medium-wave broadcasting transmitter, the field-strength measuring equipment may consist of a screened loop aerial and a calibrated receiver; the whole equipment will be so small in comparison with a wavelength that its effect on the field to be measured will be negligible. In measuring the field strength produced by a microwave source, the

situation is different. It is quite impossible to make an aerial and receiver unit small in comparison with a wavelength, and a different approach must be adopted.

The method developed by the authors makes use of the reaction on the microwave source produced by placing a short thin metal rod at the point at which the field is to be determined. The rod must then be small enough to satisfy the principle that the field to be measured must not be significantly perturbed (except in the immediate neighbourhood of the rod), but at the same time, not so small that the reaction on the source cannot be detected at all.

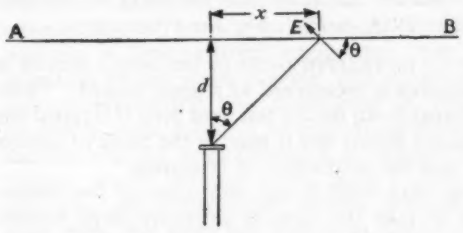
A further complication in practice is the unavoidable presence of unwanted reflections which may be confused with the reflection from the small metal rod. This is overcome by "tying a label" to the waves reflected from the rod, a feat performed by rotating the rod about an axis at right angles to its length so as to modulate the waves at a characteristic frequency, and the receiver is then arranged to discriminate against any other waves.



1 *Arrangement for rotating and controlling the position of the scattering rod*

The general arrangement of the apparatus is illustrated in Fig. 1. Two Magslip motors drive the two ends of a nylon cord to the centre of which the rod is fixed. Another motor driven from the same supply drives a mechanical phase-sensitive rectifier which provides the necessary discrimination against unwanted signals.

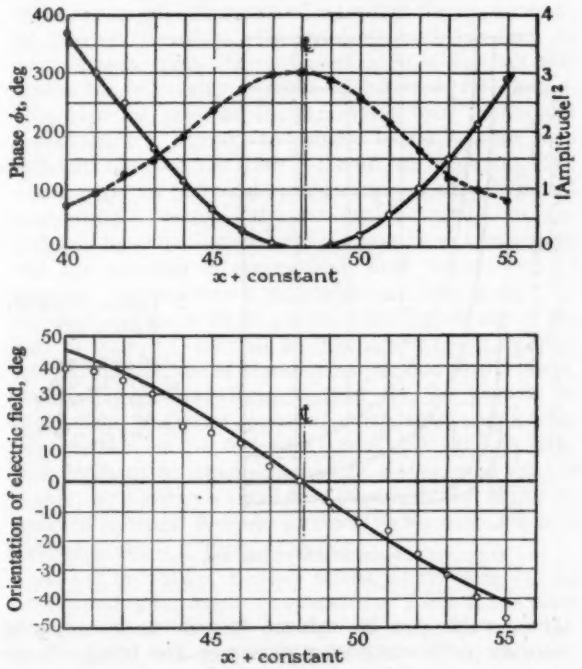
The use of the instrument is illustrated by an experiment schematically shown in Fig. 2 in which the rod is



2 *Experimental arrangement for measuring the changes in amplitude, phase and orientation with change of position*

E represents the electric field at distance *x* from the axis of the waveguide.

moved along the path AB across the mouth of a waveguide radiator, and the phase, orientation and magnitude of the electric field are measured. Fig. 3 shows that good



3 *Variation of phase, amplitude and orientation of electric field with the position of the rod*

—— Theoretical curves.
○○ } Experimental points.
●●

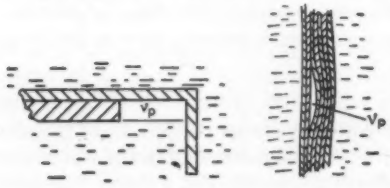
agreement with theory is obtained for phase and orientation. No adequate theory is available for the amplitude variation.

Trapped Gases in Transformers

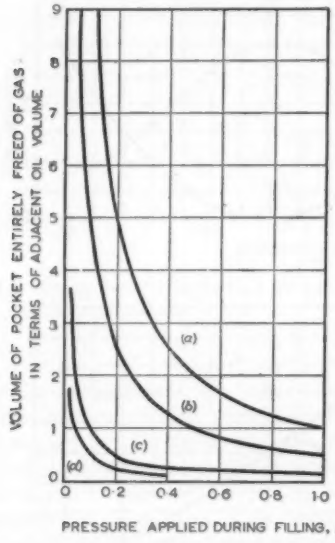
A digest of a Supply Section paper (No. 1870) entitled "The Solution of Gas in Oil during Transformer Filling," by E. B. Franklin, Associate. The full paper is published in December, 1955, in Part A of the Proceedings.

THE PRESENCE OF TRAPPED GASES IN THE INSULATION OF A h.v. transformer is recognized as a great hazard. There is risk of breakdown during test, and even if trapped gas is not detected during test it may be the cause of corona in service and the destruction of insulation.

Such gas may exist in the interstices of the fibrous insulation or take the form of relatively large pockets lodging in the transformer structure, as shown in Fig. 1.



1 *Pockets of trapped gas in transformer insulation*



2 *Volume of pocket freed of gas*

Initial pocket gas:
(*a*) CO_2; $p'_{ga} = 0$.
(*b*) CO_2; $p'_{ga} = 0{\cdot}5$.
(*c*) Air; $p'_{ga} = 0$.
(*d*) Air; $p'_{ga} = 0{\cdot}5$

These voids can be reduced in volume by applying vacuum to the transformer during or after filling. However, in practice the only method of completely eliminating gas is to cause its solution in the oil. The quantity that a given volume of oil can further dissolve is given by

$$(p - p'_g)kv_{oa}$$

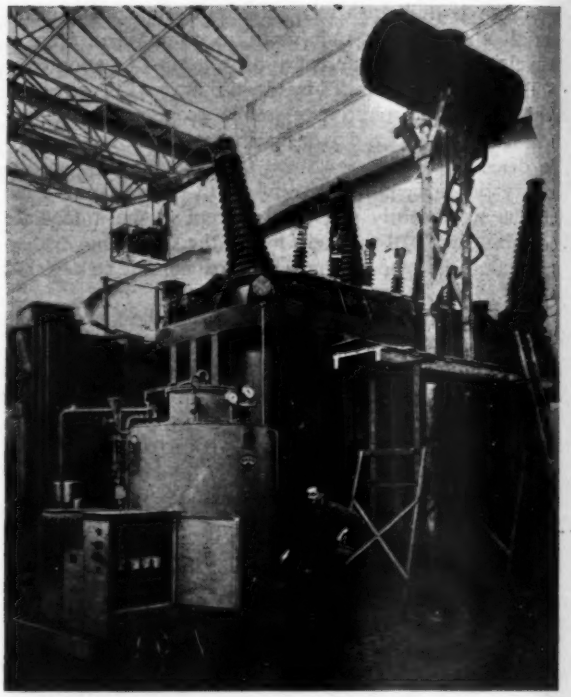
where p'_g = Initial partial pressure of gas in solution.
p = Final partial pressure of gas on the oil.
v_{oa} = Volume of oil adjacent to a pocket of gas.
k = Bunsen coefficient.

In order to make full use of solution, p'_g must be low, and k must be as high as possible. By degassing the oil p'_g can be lowered. Representative figures for k are:

N_2; 0·083. Air; 0·094. CO_2; 1·0.

Thus it is obviously an advantage to arrange that the gas in the insulation before oil filling is carbon dioxide instead of air or nitrogen. Fig. 2 shows the extent of absorption and compares different initial gases.

Conditions at site are not usually ideal for applying a high vacuum to a transformer and for the degassing of oil during filling, as in Fig. 3. The saturation of the insulation would therefore be aided if new transformers were received on site already filled with carbon dioxide.



3 *Degassing a large transformer in the factory*

The Growth of Industry

A digest of a Graduates and Students Section paper entitled "Inventions and their Influence on Industrial Organization and Management," by W. G. Bryce, B.Sc., Graduate. The paper was awarded a Students' Premium by the Council, and a long abstract of it was published in the Students' Quarterly Journal, September, 1955.

IN THE DEVELOPMENT OF ANY INDUSTRY THERE ARE FOUR well-defined stages. First there is the "materials phase" when a new process is discovered; this is followed by the "machine phase" in which plant is invented to carry out the process more cheaply. Next comes the "organization

phase," when the process is ready for large-scale production, and finally the "methods phase," when the utmost economy of manpower and materials is sought. In the development of industry as a whole, there have been four historical periods. The early Industrial Revolution, from 1750 to 1800, was followed by improvements in machines, materials and transport, covering the period to 1870. Then came a series of more complicated inventions requiring entirely new production processes for their manufacture, and finally the period from 1914 to the present day when there have been fewer fundamental inventions but more emphasis on industrial organization and applications of existing inventions.

The revolution in manufacturing processes first took place in the cotton industry as this had the simplest techniques. The industry was originally carried out on a domestic basis, but by 1750, simple machines had been invented for textile manufacture, and to keep up with rising demand these were applied to cotton manufacture. As machines became larger they needed to be power-driven, first by water-wheels and later by steam-engines—thus necessity stimulated invention, and improvements in one industry demanded improvements in others. Early steam-engines were inefficient and jerky in operation, but by 1800 they were sufficiently reliable to power the new textile factories. But the steam-engine and textile machinery would never have been successful without improved methods of iron production and metal working. During this period a factory system had evolved to meet consumer needs, and because the old domestic methods of manufacture could not compete with the new machines, workers were increasingly forced to find employment in factories, whose managers' sole problem was to organize production for an ever-expanding market.

The main factor hindering large-scale industrial expansion was the lack of an adequate transport system, especially over land. In the middle of the 18th century, the only provisions for land transport were badly surfaced roads of very small carrying capacity, mainly used by the pack-horse. An improvement came when canals were built, linking the main industrial areas of the country with each other, but these were only a partial solution, since their cost meant that only a small mileage could be constructed linking the larger towns. Land transport was really improved only by the coming of the railway, the first economic railway locomotive being developed by George Stephenson in 1830. With the arrival of railways, the nation and not the district became the economic unit—each area could now specialize in the products which it could produce most easily. Later, improvements in sea transport resulting from the application of the steam-engine to ships meant that eventually the world, and not the nation, became the economic unit. Other major factors assisting industrial expansion were the beginnings of standardization and the invention of a large-scale method of steel manufacture in 1856. By 1870 the economic size of firms was increasing making it more difficult for a person to set up on his own. Management was becoming a matter of finance as well as of production.

Industrial development was now at a sufficient level to enable new inventions to come about. Typical of the new inventions were the internal-combustion engine and the applications of electricity, the latter shattering the Victorian idea that steam power would eventually replace manual work and domestic drudgery. Real progress in heavy-current engineering came with the invention of the steam turbine, and progress in light-current engineering was accelerated in 1907 by the invention of the triode. The internal-combustion engine enabled efficient land transport to penetrate to every locality. So, by the turn of the century, a new series of industries was growing up, entirely different from the older ones. But these new industries had to produce in large quantities and to be organized on a large scale for efficient operation, for the new products were technically complex and required costly plant for their manufacture. As firms grew in size, new management methods had to be evolved, e.g. the functional system where one person is entirely responsible for supervising related activities such as the various aspects of production or of research.

From 1914 to the present day the evolution of fundamental inventions has slowed down, and further advance has been largely the result of extending the applications of existing inventions. The main emphasis has been on organization, both internal and external—in fact this period has been called the Second Industrial Revolution. One type of external reorganization was "horizontal combination" among industries where selling was difficult; this took the form of a trust, cartel or ring. The other type of external reorganization was "vertical integration" among industries which supply, or are supplied by, other industries (e.g. a motor-car firm buying out the suppliers of accessories). Both these forms of external reorganization depended on the growth of industry and led to larger plants. With the increase in the size of industry, internal reorganization could develop by the application of standardization and work study. Another important factor helped by the growth of larger firms was more applied research, since only a large organization can (or feels that it can) afford this. A large firm tends to be expansion-minded and to plan for the future; by contrast a small firm often feels that it has no need of technical progress in times of boom and that it cannot afford it in times of slump.

As for the future, a major industrial problem will be an increasing shortage of conventional fuels. It has been estimated that at the present consumption rate the conventional fuel reserves of the world will last only 400 years. Thus the tendency will be to use atomic fuels, saving conventional fuels for purposes for which they cannot be replaced. Another future industrial problem will be a shortage of skilled labour, which can be overcome by utilizing automatic production procedure for routine processes more widely than at present, thus releasing labour for other occupations. But in the future, as in the past, industrial organization will be determined by the size of the market and the technical nature of the product.

HOME EVENTS

LONDON

ORDINARY MEETING

Thirty Years On

The New High-Frequency Transmitting Station at Rugby was the title of the paper presented by Captain C. F. Booth and Mr. B. N. MacLarty at the Ordinary Meeting held on the 3rd November, 1955. Sir George Nelson presided over a large gathering which included many well-known engineers associated with the "old original" Rugby station, built some thirty years ago. A special article on the paper will appear in a future issue of the *Journal*.

In presenting the paper Captain Booth stressed the flexibility of the integrated system of cable and radio circuits, in which the new station has now taken its place. The station is on a site very near to the Rugby long-wave station; it comprises 28 transmitters and the associated aerials, providing world-wide telephony and telegraphy services. Captain Booth described the station as an "experiment in design" and picked out for special mention the centralized facilities for remote control of both transmitters and aerials, and the centralized monitoring facilities. The station can be completely controlled and monitored by two operators from a central control position. This has led to two important savings, the time spent in frequency changing, and the number of operating staff. In passing, Captain Booth mentioned that Fig. 14 in the published paper seemed to have been set up for the Australian circuit—it was printed upside-down!

The paper was followed by a short film showing the opening of the station by the Postmaster-General, Dr. Charles Hill; many members of The Institution appeared as "extras."

The discussion was opened by Mr. H. Stanesby. He referred to the importance of efficient use of the frequency spectrum, and went on to discuss the possibility of using scatter techniques to provide additional circuits. Ionospheric scatter systems, he thought, seemed unlikely to be of practical value for normal services on account of the technical difficulties; tropospheric scatter systems remained a distinct, if remote, possibility.

Mr. H. Faulkner, who was at one time Engineer-in-Charge at the Rugby long-wave station, compared modern practice with that of thirty years ago, and praised the results of co-operation between user and supplier which has yielded the outstanding results exemplified by the new station.

Mr. J. A. Smale, in provocative mood, questioned some of the major planning decisions relating to the design of the new station. For instance, he asked whether the complexity consequent upon standardization was worth while, in view of the fact that some transmitters worked steadily on one circuit with the same type of traffic year after year. The use of rhombic aerials also came under fire from Mr. Smale (not for the first time) on account of the energy wasted in the termination, the annual value of which, since the cost of h.f. power approaches 2s. 6d. per unit, he estimated to be £100000 at the new station.

Col. D. McMillan spoke highly of the practical performance of the station and said it would be a pattern for future Post Office installations.

Mr. A. N. Thomas compared the curtain arrays used for broadcasting with the rhombic aerials used at Rugby, pointing out that the more severe broadcasting demands ruled out the compromise typified by the rhombic. He also asked a number of questions relating to the feeder system and to the design of the transmitters. Some of these points were dealt with by Mr. W. J. Morcom, who described some of the factors influencing the design of transmitting equipment. Mr. A. Cook discussed some economic considerations affecting the planning of the station.

It was unfortunate that there was only time for speakers invited by the President to take part in the discussion. There were many points concerning both the general planning and the detailed design of the new station which merited fuller discussion.

In replying for the authors, Mr. MacLarty commented on some of the points raised, including the questions of cooling, noise, and continuously variable inductors.

A praiseworthy feature was the comprehensive display of components available for inspection after the meeting. These ranged from small tuning condensers to a complete aerial switching assembly, and evoked great interest.

H. P.

MEASUREMENT AND CONTROL SECTION

Measurement Section Well Under Control

The new session of the Measurement and Control Section got off to a very good start at its first meeting on the 11th October, when Mr. W. Bamford delivered his Chairman's Address to an interested audience which included a gratifying number of ladies.

The Section was honoured by the presence of the Earl of Mount Edgcumbe, Past-President, who was, in 1928, its first Chairman, and who, besides reading a telegram of greetings and good wishes from the President, made a short and happy speech in which he referred to Mr. Bamford's long association with him.

The retiring Chairman, Mr. Whitehead, announced the award of Premiums to many members of the Section, which had clearly put up a very good show in the quality of its papers during the last session.

Mr. Bamford, in his Address, chose a very fitting subject, *Measurement and Control*, in view of the change in the Section's name, and dealt with it in a masterly fashion. Regarding himself as a qualified "looker-on" in the rapidly expanding field of automatic control, he

proceeded to prove that very little of its game was escaping him. Having exposed much of the journalistic nonsense associated with that horrid word "automation," he showed conclusively that automatic control in industry had been long developing, and that far from displacing labour, it would greatly increase the productivity of the already over-scarce supply of labour. It was the only way in which the additional plentiful goods required for a higher standard of living could be had in a country where the future increase in the labour force seemed negligibly small.

Mr. Bamford, talking to measurement engineers, said that measurements had no virtue in themselves. It was what was done with the measurements that really counted. Measurement engineers ought to take much more interest in what finally happened as the end-product of their activities.

It was also suggested that digital computer technique was now advanced to the point where it could be applied to the study of a country's economy and would enable the effects of corrective measures to be tried out painlessly and quickly enough to be really remedial.

There followed some warnings. Automatic control is not an entity and must be tailored to suit the needs of each industry. Products, as well as tools, need to be designed for automatic control processes. Electrical measuring instruments used for sensing may need to be built to a new level of performance. The specialists in the techniques involved must, as well as discussing their problems with fellow-specialists, see that the people who will apply the techniques are made fully aware of the possibilities. All involved must never lose sight of the social consequences of their work.

Listening to Mr. Bamford, one could not avoid the thought that a condensed version of his Address could well be given to the public at this time, when its subject is so topical and so much misunderstood.

Dr. Denis Taylor moved the well-supported vote of thanks for the Address. Among other remarks, he said that he would like an automatic kitchen to save his wife work, but doubted if he could afford to keep a maintenance engineer. The retiring Chairman, Mr. Whitehead, was thanked for his year of work for the Section, which obviously appreciated his services on its behalf, and Mrs. Whitehead was thanked for allowing him so much "time off." In reply, Mr. Whitehead said he had enjoyed the work, and paid tribute to the loyal help of the Institution staff. H. S. P.

RADIO AND TELECOMMUNICATION SECTION

Extending in Line

Mr. H. Stanesby delivered his Chairman's Address to the Section on the 19th October, 1955.

His principal theme was the development of multi-channel line and radio systems and the need to co-ordinate these systems so that integration of both into main trunk telecommunication networks could be economically and satisfactorily achieved. He first briefly traced the history of line communication, showing how the use of frequency division multiplex technique made it possible by the beginning of the Second World War to transmit several hundred telephone conversations on each pair of coaxial tubes in a cable. Meanwhile, in the United Kingdom, radio links capable of transmitting up to about 24 channels were being used chiefly for providing circuits between islands and the mainland.

Owing to the growth of radar during the war an impetus was given to the development of radio and valve techniques which was turned to account after the war by the development of broad-band communication links in the u.h.f. and s.h.f. frequency ranges. Systems equivalent to a multi-tube coaxial cable were now available and to these multiplexed telephone or television channels could be applied. The International Telephone Consultative Committee (C.C.I.F.) had already done much towards the standardization of carrier systems operating over wire lines and recently the International Radio Consultative Committee (C.C.I.R.) had been very active in proposing standards for broad-band radio links in order to ensure that C.C.I.F. performance would be met on individual channels, and that interconnection of blocks of circuits over line and radio systems could be effected in a flexible and co-ordinated manner.

Dr. R. C. G. Williams, Senior Vice-Chairman, in moving the vote of thanks remarked that it was a singularly happy circumstance which found Mr. Stanesby in the chair immediately after the extension of the Radio Section's activities to cover line communication. Mr. Stanesby had been prominent in the field of coaxial cable systems in the past as he now was in the whole field of radio communication. It was fitting, therefore, that he should hold the responsible position of Chairman of International Study Group IX of the C.C.I.R., which dealt with the standardization of radio links and their co-ordination with line systems. A. M. T.

SUPPLY SECTION

Fully Fledged

Wednesday, 26th October, 1955, the day of its opening meeting of the session, marked the Supply Section's coming-of-age. This agreeable news was announced to the gathering by the President, Sir George Nelson, who offered his congratulations to the Section on attaining its years of discretion. The day was, he said, by a coincidence also his own birthday; and he had forgone an evening of leisured celebration in the bosom of his family—recently augmented—to attend the induction of the Supply Section's new Chairman.

The meeting was graced by several ladies, whose presence is always the more welcome at the opening of a session because they are conspicuously absent at most other times. Sir John Hacking and Mr. S. E. Goodall were in the audience, and a welcome was given with acclamation to Dr. and Mrs. R. E. Heartz and to

Dr. L. Austin Wright. Dr. Heartz is the President of the Engineering Institute of Canada and Dr. Wright is its General Secretary; they have been over in Britain on a visit of goodwill and to foster the influence of the "big three" British professional engineering Institutions.

Mr. J. D. Peattie, the retiring Chairman, who was described as everybody's ideal uncle because he radiates benevolence, charm and a twinkle in the eye, introduced his successor, Mr. L. Drucquer, and called on him to give his Inaugural Address. This was beautifully delivered with calm precision and admirable timing, and was illustrated with lantern slides that told their story at a glance. Mr. Drucquer's subject was the manufacturing industry—past, present and future. In the past, he said, we have been profligate with our natural resources; while in the future even heavier demands will be made on the electrical manufacturing potential, for not only must the supply of energy be increased and the supply of essential new raw materials secured, but the supply of trained young men must somehow be stimulated. The volume of the world's electrical plant doubles every ten years; the mighty generators of one decade become the toy machines of the next, 140 MW alternators are almost here, and 200 MW machines are round the next corner. Everything gets bigger and (we hope) better.

It is not unusual for a Chairman's Address to be devoted to a broad view, seen through the eyes of experience and coloured by the years of devotion to one part of the electrical art. There is much to be said for such a theme. It appraises the past in order to inform, direct and encourage the forward march. Though we may be "full of care," it is salutary on an occasion like this for us to take time off to stand and stare.

The motion of thanks was proposed by Professor M. G. Say and supported very warmly by the audience. On taking the chair, Mr. Drucquer called upon the President for a short speech, and then on Dr. L. G. Brazier and Mr. L. H. Welch to propose and second the vote of thanks to Mr. Peattie for his year's work. Mr. Peattie, it appears, is a Scot who took the well-known golden road across the Border. He has certainly delighted the Supply Section with his warm humanity, and takes his place in the ranks of the Past-Chairmen with the thanks of the members for a year of devoted service.

M. G. S.

LEEDS

NORTH MIDLAND CENTRE

Chairman's Address

The retiring Chairman, Mr. W. A. Crocker, in opening the first Ordinary Meeting of the Session on the 4th October, 1955, asked senior members to attend Graduates and Students Section meetings and thus help to forge a most valuable link between the younger engineers and the ordinary members. He welcomed four new Corporate Members and the new Secretary, Mr. H. A. Carr, and then vacated the chair in favour of the new Chairman, Mr. F. Barrell. Mr. J. R. Rylands, in humorous vein, expressed the thanks of the Centre to Mr. Crocker, and was ably supported by Mr. A. J. Coveney who made reference to the York visits and papers which Mr. Crocker had so kindly and efficiently arranged in the past six or seven years. In reply Mr. Crocker wished the North Midland Centre well for the future. Mr. F. Barrell then gave his Chairman's Address entitled *The Development of Power Station Construction in Leeds and the Surrounding Area*. Mr. Barrell introduced the subject with a brief historical survey, and then dealt vividly and fully with recent construction. The Address was delivered in a style which maintained the interest of the assembly throughout. Mr. H. S. Moody proposed the vote of thanks to Mr. Barrell, saying he had never before seen so fine a set of coloured lantern slides as the ones which had just been shown. Mr. W. K. Fleming, in seconding, said it was not inappropriate that two Area Board Engineers should thank a Divisional Engineer, who after all provides their daily bread.

Mr. J. G. Craven collected nearly £18 in response to his appeal for the Benevolent and Homes Funds.

The Chairman presented an Extra Premium to Professor G. W. Carter for his paper *A Note on Laminations*, and the Baillie Memorial Prize to Mr. P. H. Sinclaire for his Students' paper *Electrical Distribution in Germany*. The thanks of the Centre to the recently retired Honorary Secretary, Mr. G. Harlow, whom all were pleased to see once more, were voiced by Mr. G. Caton in a fitting manner, and Mr. Harlow, in accepting the Certificate and a copy of *The History of The Institution*, modestly disclaimed Mr. Caton's generous tribute.

Chairman's Ingenuity Taxed

At the Second Ordinary Meeting on November 1st, the Chairman, Mr. F. Barrell, welcomed four new Corporate Members. He announced that the Centre's Golf Competition will be held at Sandmoor on the 15th May, 1956, and appealed for greater support from members. He called on two speakers to explain the working of the Graduates and Students Section and, in short, gallantly held the floor for nearly half an hour until the arrival of the speaker, Sir Gordon Radley, whose train had been delayed. Sir Gordon soon captured members' hearts by the sincerity of his apology, and their imagination by the substance of his paper *A Transatlantic Telephone Cable*. In closing, Sir Gordon emphasized the necessity of using proved valves and proved techniques in this project, and said that the cable was now being used for speaking from west to east and was slightly better than the specification called for.

Opening the discussion, Col. H. B. Somerville said the effect of this project on the relationship between the New World and the Old would be profound. He was ably supported by six other members who ranged over the whole subject both adequately and humorously. It was evident that all these speakers were most impressed by the work done by the author and his colleagues.

Sir Gordon very fittingly answered the questions raised in the discussion with many racy replies, and he was congratulated on being awarded the John Hopkinson Premium and the Christopher Columbus Prize. The Chairman thanked Sir Gordon for his fascinating account of this wonderful enterprise.

NORTH MIDLAND UTILIZATION GROUP

"Who is Right?"

At the Opening Meeting of the Group, which took place on October 18th, the retiring Group Chairman, Mr. N. S. Goddard, introduced the new Chairman, Mr. J. C. W. Wilkinson, who then assumed the Chair. A vote of thanks to Mr. Goddard was very wittily proposed by Mr. N. S. Sellers, and after Mr. Goddard had suitably replied, the meeting proceeded to the paper *Design, Performance and Application of Miniature Circuit-Breakers* by Mr. H. W. Wolff and Mr. F. Atherton. Mr. Wolff read the paper and Mr. Atherton joined him in answering the questions raised in the discussion. The paper compares the widespread use of miniature circuit-breakers in the United States and the Commonwealth with their extremely sparse use in Britain, and poses the question, "Who is right?" The discussion opened by Mr. E. Ellis and supported by eight other speakers dealt very fully with the many interesting points raised in the paper and showed the majority of speakers to be against the use of miniature circuit-breakers in domestic premises.

The Chairman thanked the authors, and before closing the meeting announced that the response to Mr. J. G. Craven's appeal for the Benevolent and Homes Funds was nearly £6. J. L.

MANCHESTER

NORTH-WESTERN CENTRE

Engineering Ethics

The enthusiasm shown by the 200 people present at the opening meeting of the North-Western Centre at Manchester on the 4th October, 1955, was a most encouraging sign, pointing to another successful session.

The retiring Chairman, Professor E. Bradshaw, opened the proceedings by welcoming all present, among whom it was his special pleasure to greet 14 Past-Chairmen of the Centre, the two senior Past-Chairmen present being Mr. J. S. Peck and Sir William Walker, who served in 1910–11 and 1921–22 respectively. It was an inspiration to know that those who had taken so prominent a part in the affairs of The Institution in the past should still show an active interest in its progress.

After welcoming three newly elected Corporate Members, Professor Bradshaw presented ten premium certificates awarded to members of the Centre, and the North-Western Centre award to the Student who in the opinion of the Committee had delivered the most meritorious paper before the North-Western Students' Section last session.

It was next Professor Bradshaw's duty to introduce and induct the newly elected Chairman, Mr. G. V. Sadler, for the 1955–56 Session.

Mr. Sadler, in accepting this honour, thanked the members and the Committee for electing him to the chair. He spoke appreciatively of Professor Bradshaw's year of office and presented him with a certificate as a record of this. He also gave him, in appreciation of his services, a copy of *The History of The Institution*, suitably inscribed, and containing the signatures of all the members of the Committee.

The Address by the Chairman entitled *Ethical Aspects of the Electrical Engineering Profession* opened up a different and wider sphere of thought than the more usual straightforward technical type of Chairman's Address. Mr. Sadler treated his subject in a masterly way, and there was no doubt that he held the interest of his audience and gave them much to think about.

A vote of thanks to the Chairman was proposed by Professor Bradshaw, and seconded by Mr. F. R. Perry, Vice-Chairman, and this was carried with acclamation.

Mr. W. E. Swale, Local Honorary Treasurer of the Benevolent Fund, spoke on the working of the Fund by relating cases from his personal experience, and he urged members to make regular subscriptions. He explained that the draw held at the opening meeting in the past was being deferred until nearer Christmas when it was felt that the response might be greater. T. T. E.

NORWICH

EAST ANGLIAN SUB-CENTRE

Salve

The newly formed East Anglian Sub-Centre held its Inaugural Meeting on October 12th, at the Assembly House, Norwich. Mr. F. R. C. Roberts, Chairman of the East Midland Centre, took the Chair and welcomed Mr. T. E. Goldup, Dr. J. H. Mitchell, Sir Vincent de Ferranti, Prof. E. B. Moullin and Mr. W. K. Brasher. He then asked Dr. Mitchell to address the meeting.

Dr. Mitchell said he was very glad that the new Sub-Centre was born during his year of office as Chairman of the East Midland Centre, and he joined Mr. Roberts in bringing best wishes for the success of the new Sub-Centre from the East Midland Centre.

Mr. Goldup was then asked to address the meeting. He said that in his visits to Centres and Sub-Centres he was always inspired by the enthusiasm of local members. This Sub-Centre was the sequel to a series of successful District Meetings which had been organized for many years in Norwich, Cambridge and Ipswich and he felt sure that Messrs. J. A. Sumner, R. A. W. Connor and N. Hiller were pleased with the outcome of their efforts. He thought that the Sub-Centre must give attention to the needs of the younger men because sooner or later it was to them that we had to hand on the affairs both of

the profession and of our great Institution. On behalf of the President and the Council he wished the new Sub-Centre every success.

Mr. Brasher spoke next, saying that he felt that all members owed a debt of gratitude to the work of Local Committees; the amount of voluntary work that was carried out always impressed him. He reminded members of the good work being done by the Benevolent Fund but they should also think of the Homes Fund. The target had not yet been reached and it was of advantage to make a covenant to donate as much as could be afforded to the Fund. Members from the provinces were always welcome on their visits to London and the staff would always be pleased to arrange for members to see the homes on "The Chesters" estate, or The Institution's film about them.

Mr. Roberts then called on Mr. E. T. Norris, Chairman of the Sub-Centre, to deliver his Inaugural Address, and handed over the chair to him at its conclusion. The title of the address was *Human Effort in Engineering Progress*. Mr. Norris divided his main theme into three parts. In the early days effort was individual and isolated, later this became general but uncoordinated, and finally it gave way to the present organized and directed effort. To illustrate his remarks he gave a number of amusing examples from the effort of early workers, and gave everyone much valuable food for thought.

A vote of thanks to Mr. Norris proposed by Mr. J. A. Sumner was carried with acclamation.

A collection for the Benevolent Fund realized £2 10s.

R. A. W. C.

OXFORD

DISTRICT MEETING

V.H.F. Broadcasting

The first District Meeting of the session was held at the Southern Electricity Board's offices in Oxford on the 12th October, 1955. Mr. J. L. Taylor, the Convener, gave a brief report on District activities; then Mr. W. H. Lee took the chair for the meeting and invited Mr. H. Page, M.Sc., to read his paper on v.h.f. broadcasting.

Mr. Page introduced the subject by referring to the growing congestion on the medium-wave band and explained how, in order to arrest the declining coverage, the B.B.C. had been forced to exploit frequencies in the v.h.f. band. The lecturer then outlined tests made some three years ago to determine the probable service areas and to decide whether frequency or amplitude modulation would best meet the interference problem in built-up areas. These tests clearly showed the merits of frequency modulation and also enabled the B.B.C. to draw up a plan for national coverage.

The generation and demodulation of an f.m. carrier was explained and Mr. Page described a typical transmitting unit. Of particular interest was the transmitting aerial, which so greatly increases the effective radiated power. He concluded by indicating the locations of the transmitting stations and the anticipated coverage of the national v.h.f. network.

After refreshments, a demonstration was given of the signal/noise ratio of locally generated f.m. and a.m. signals and this provoked an interesting discussion on the performance of the two systems in the presence of an interfering carrier outside the audio band. During the more formal discussion many speakers expressed the view that Oxford would not be well served by the f.m. transmissions so far made public in spite of the difficulties of medium-wave reception in Oxford.

A vote of thanks was proposed by Mr. F. E. Liddiard. Before the meeting closed Mr. W. F. Smith (Past-Chairman of the North Midland Centre) spoke of the value of District Meetings to country members. The Oxford District, he thought, managed their affairs very well both in the range of subjects and the quality of discussion.

W. H. L.

READING

DISTRICT MEETING

Men in Demand

The session's first District Meeting at Reading took place on the 17th October, 1955, under the presidency of Mr. Forbes Jackson, and in view of the extremely cold night the attendance of 40 was perhaps as large as could be expected.

The lecture by Dr. A. G. Beverstock, the Education Officer to the Southern Electricity Board, on *The Electrical Industry—Career Opportunities and Training Schemes*, proved to be of considerable interest to everyone present and there were many expressions of appreciation from the special visitors.

Dr. Beverstock said that the industry is divided into three main sections. The manufacturing side employs some 650 000 people (thirty years ago 150 000) and there are a multitude of careers open to craftsmen, technicians, technologists, scientists and administrators. The supply side is responsible for generation, transmission and distribution of electricity and now employs 190 000 people (156 000 in 1949) of whom 11·5% are women. It offers a variety of careers; in the crafts as mechanical or electrical fitters, meter mechanicians and electricians; in engineering as surveyors, designers and construction, operation and maintenance engineers; in the office as shorthand typists, clerks, administrators, accountants, solicitors, etc. Many careers are open to women and some are particularly attractive, such as service-centre assistants and demonstrators. The contracting side, still the stronghold of small business, offers careers as installation and maintenance electricians, armature winders, repair workers and installation supervisors; for technicians and engineers in planning, inspection and testing; and specialized work in drawing offices, accounting, clerical work and storekeeping.

There are five types of apprentice training schemes common to all sides of the industry:

(*a*) Pre-apprenticeship schemes for boys aged 15.
(*b*) Five-year craft apprenticeships.
(*c*) Four-to-five-year student apprenticeships.
(*d*) Two-year training schemes for graduates from universities and technical colleges.
(*e*) College apprenticeship schemes.

The system of day-release for college study is now almost universal, but increasing attention is being given to the development of sandwich schemes for training electrical engineers. This comprises a 4-year period with six months' full-time attendance at college in a year.

The industry is giving attention to the broader training of apprentices through apprentice associations, visits to industry abroad, attendance on courses at the Outward Bound schools and certain residential colleges.

Increasing attention is being given to post-apprentice training, i.e. the training of supervisors, managers and specialists. Manufacturers organize annual schools; electricity Boards have comprehensive training courses and conferences for all levels of staff; the Central Electricity Authority have two residential training centres, where since nationalization 45 000 members of the staff have attended courses and conferences; and Spring and Summer Schools are organized at Oxford and Cambridge.

There has been phenomenal expansion in the electrical industry and the recruitment position is acute. The demand for electricity is doubling itself every ten years and 45 000 MW of new plant (including nuclear reactors) must be installed over the next twenty years. Manufacturers must double or treble their programmes to keep pace with oversea developments. New projects will be seriously retarded and some may have to be abandoned if an adequate supply of technically or scientifically minded young men and women do not enter the industry.

We are at the beginning of another amazing era of technical development and there is a great danger that technologists will be trained at the expense of human understanding. It will be a barren era if insufficient attention is given to the development of width of outlook and the education of the whole man. However, the leaders of the electrical engineering industry are alive to this danger and many are doing something about it.

At the conclusion of the talk the film *The Inquiring Mind* was shown and was much appreciated by the audience, which included a number of visitors from educational establishments in a wide area around Reading; so keen was the discussion which followed that it was a late hour when Mr. R. Swingler, one of the visitors, proposed a hearty vote of thanks to Dr. Beverstock.

H. R. J. B.

SCOTLAND

SCOTTISH CENTRE

The opening meetings of the North Scotland Sub-Centre, briefly referred to in the November *Journal*, took place at Dundee and Aberdeen on October 6th and 7th, respectively. At Dundee the new Centre Chairman, Dr. E. Wilkinson, was introduced by Mr. J. S. Hastie, the retiring Centre Chairman, and at Aberdeen, after the customary and most enjoyable Inaugural Dinner, Dr. Wilkinson was introduced by Mr. C. H. A. Collyns, Past-Chairman of the Centre. Mr. Collyns also presented to Mr. J. E. Whitaker, the retiring Sub-Centre Chairman, a copy of *The History of The Institution*. In both cities Mr. J. Knox, the new Sub-Centre Chairman, delivered his Chairman's Address on *Interference Problems*. With the aid of illustrative diagrams and valuable statistics, Mr. Knox dealt with the interference with telephone communication caused by induction from power-transmission circuits, the interference with the life of buried structures caused by electrolytic corrosion resulting from stray currents, and the interference from various causes with radio and television reception.

Since the authors of the paper to have been read before the South-West Scotland Sub-Centre in Glasgow on November 2nd found themselves unable to present it, Professor F. Bruce undertook, at a few hours' notice, to give an informal talk on his recent tour in the eastern parts of Canada and the United States. Professor Bruce visited a number of universities and research laboratories, particularly those concerned with high-voltage work. The universities appear to suffer from a rather low and very variable standard of entry, and consequently undergraduate work is often at a standard below that of this country. However, the post-graduate courses organized both by the universities and by industry reach a very high standard indeed. The high-voltage laboratories visited were, on the whole, well equipped, but were used more for routine testing than for fundamental research. The talk was made all the more interesting by many anecdotes and scenic illustrations, and Professor Bruce left the impression that while there is much that we can learn from the New World there is also much that we can teach it, and he found no occasion whatever to decry the work being done in this country.

Both the South-East Scotland and the South-West Scotland Sub-Centres have recently appointed new Honorary Assistant Secretaries. In South-East Scotland the duties are to be carried out by Mr. J. B. McPherson and in South-West Scotland by Mr. J. Mason. Mr. Mason has been an active member of the South-West Scotland Graduates and Students Section and was awarded a Sub-Centre prize for the best paper read in a recent session.

E. O. T.

THE WEST COUNTRY

SOUTH-WESTERN SUB-CENTRE

The 1955–56 Session opened with a District Meeting at Camborne, Cornwall, on the 12th October, 1955, convened by the first Vice-Chairman of the Sub-Centre, Mr. W. R. Rowe. Mr. G. O. McLean, M.Eng., read his paper *The Domestic Heat Pump* to an audience of 72.

Inaugural Address

The 81st Ordinary General Meeting of the Sub-Centre was held on October 20th at the Royal Clarence Hotel, Exeter. This was the occasion of the Inaugural Address of the new Chairman, Mr. W. J. Guscott. Unfortunately, the retiring Chairman, Mr. H. C. O. Stanbury, was unable to be present due to illness. Mr. J. E. Flowers stepped into the breach at short notice to open the meeting and to carry out the induction ceremony.

Having thanked Mr. Flowers for so kindly officiating, and members for their cordial reception, Mr. Guscott's first action was to express the disappointment and concern of all members that Mr. Stanbury should have been prevented from attending this meeting by illness. Mr. Guscott suggested that a letter should be sent to Mr. Stanbury wishing him a speedy return to good health. Mr. Stanbury's clear conception of the duties of Chairman, and his frank means of expression were praised by Mr. Guscott, who stated that he would do his utmost to maintain the high tradition of Chairmanship which had been established in the Sub-Centre, and to continue to promote the aims and interests of The Institution in general, and of the Sub-Centre in particular.

The new Chairman extended a hearty welcome to all new members and visitors, particularly his colleagues who had travelled from Bristol, including Mr. H. D. B. Wood. Mr. Guscott expressed great pleasure that Mr. Culmer Hodges, by whom he had been introduced to The Institution over 25 years ago, was able to be present.

Mr. Guscott then presented his Address entitled *The Investment and Production Value of Electricity in Farming*. This sets out to offer a practical method of assessing the investment and production value of electricity for farming purposes. The Address was illustrated by slides showing the effect of converting various farming operations to electricity. By applying these methods to representative farms, Mr. Guscott arrived at the investment value in terms of net profit, labour saved, and increased output per pound sterling spent annually on electricity. Estimates of total increased net profit and output were given on the assumption that farms already connected to the electricity supply, and farms to be connected under the national programme, made full and wise use of mains electricity.

The Address was presented to an audience of 61; the number of Past-Chairmen present was particularly noticeable. Mr. C. J. Hocking proposed a vote of thanks, which was received with acclamation, and members agreed that the Address had been illuminating in more ways than one.

The Benevolent Fund collection realized the sum of £5 7s. 6d.

Future Activities: Programme Changes

Certain changes in programme have had to be made, owing to the fact that Dr. Grey Walter is unable to present his paper *The Electrical Activity of the Brain*.

At the meeting to be held in Plymouth on the 1st December, 1955, Mr. R. A. L. Cole will present his paper on *Transistors*.

At the meeting on the 26th January, 1956, in Torquay, a paper entitled *Electrical Energy from the Wind* will be read by Mr. Golding.

The remainder of the programme remains unchanged.

Members of the Sub-Centre are very pleased that Dr. Willis Jackson has promised to attend the meeting in Torquay on the 10th May, 1956. G. B. H.

NEWS *from abroad*

QUEENSLAND

Some 65 members and guests, including members of the Brisbane Division of The Institution of Engineers, Australia, were present at a meeting organized by the Queensland Oversea Committee held in the University of Queensland, Brisbane, on the 19th July, 1955.

The Chairman of the Queensland Oversea Committee of The Institution, Mr. J. S. Just, occupied the chair, and introduced the speakers for the evening, Mr. R. D. Taylor and Mr. L. E. Robinson, who then delivered a paper entitled *Recent Developments in the Design and Performance of Radial-Flow Turbines*. They described research and development activities in blading design and construction, indicating their effect on the performance and efficiency of this particular type of steam turbine as used in power stations. The lecture was well illustrated with lantern slides, and was followed by an excellent and searching discussion. A vote of thanks to the speakers was proposed by Mr. J. E. G. Martin.

A. S. F.

OVERSEA ATTENDANCE REGISTER

During the period 1st October to 31st October, 1955, the following members called at the Institution Building and signed the Attendance Register of Oversea Members:

CORNISH, H. E., M.C., B.Sc.(Eng.) (Kuching, Sarawak).
HAIGH, R. W. (Bolawayo).
HILL, D. S. (Hong Kong).
McDONALD, J. R., B.Sc.(Eng.) (Kingston, Jamaica).
MILLER, W. L. E. (Hong Kong).
PARTRIDGE, J. E. (Ottawa).
PROCTER, I. (Nairobi).
REY, N., B.Sc.(Eng.) (Port Louis, Mauritius).
SUNDARAM, S., B.Sc.(Eng.) (Calcutta).
ZANOBETTI, D., Prof., Dr.Ing. (Bologna, Italy).

OBITUARY

ERNEST PIKE LUCKING

Ernest Pike Lucking, who died on the 9th December, 1954, was born on the 31st October, 1890.

He was educated at a small private school in Leighton Buzzard, and at the Regent Street Polytechnic, London, where he was awarded a first-class diploma, and received practical training at the Electro Medical Supply Co., London, from 1905 to 1906. In 1909 he worked in the drawing office of Adams Manufacturing Co. (now known as the Igranic Co.) at Bedford, and there first became associated with work on switchgear, a subject which was to occupy a large part of his business life. In 1910 he took a similar position with the General Electric Co. at Witton, and in 1912 another similar one with the firm of George Ellison, at Birmingham.

From 1912 to 1914 he held the position of Assistant to the Manager of the Electrical Department at William Geipel and Co. in London, and in 1914 he returned to George Ellison, Ltd., as District Engineer, a post he held for many years. In this capacity he was concerned not only with the technical development of switchgear but also with furthering the sales side of that ever-expanding industry. From 1930 he had sole charge of the technical and sales sides of the firm's extensive connection in London and the South of England. He was also a Director of Nathan and Allen, of London, which firm was entrusted with the export business of George Ellison, Ltd.

Mr. Lucking was a man loved and respected by all who worked with him and under him, and one to whom many outside his firm turned for advice and help. At home he was very happy and consequently his business life had a cheerful background. He was modest, unobtrusive and unselfish. His activities in golf and motoring gave great pleasure to others, and made him a welcome friend everywhere.

He joined The Institution as an Associate Member in 1934 and was elected a Member in 1947. J. F. S.

WILLIAM ALOYSIUS MACKENZIE

William Aloysius Mackenzie, who died on the 3rd October, 1954, was born on the 17th June, 1876. He was educated at a private school at Moidart, Inverness, and received his engineering education at Petershill Secondary School and the Glasgow and West of Scotland Technical College. His practical experience was gained in the locomotive works of Neilson Reid and Co., Glasgow, from 1891 to 1894. He then joined Alex Gillespie and Sons, Glasgow, and in 1895 became Foreman Erector, in which capacity he was engaged on the erection of all classes of mill machinery. In 1897 he took a post as Engineer Superintendent with the United Co-operative Baking Society Ltd., in Glasgow, and was responsible for the installation of much electrical equipment. In 1900 he joined the Glasgow Corporation Electricity Department as Boiler-house Engineer, responsible for the repair and maintenance of boiler plant and auxiliaries generating a total power of about 18 000 kW.

In 1907 he moved to London, where he held the position of Works Engineer at the West Ham Electric Supply Undertaking, and supervised all the plant in the generating station and the installation of turbine plant and auxiliaries. He then joined the Charing Cross Electricity Supply Co. in 1911 as Station Superintendent of the Bow generating station, and with the inception in 1926 of the London Power Co. he was designated Executive Engineer and later became the first Chief Superintending Engineer at the Battersea generating station, a position which he held with distinction until his retirement in 1945.

Mr. Mackenzie was a man of forthright character and marked personality, and with his passing the world has lost one more of those strong individualists, whose like has been a feature of the electricity supply industry.

He joined The Institution as an Associate Member in 1913 and was elected a Member in 1935. E. P.

JOSEPH GEARY WILSON

Joseph Geary Wilson, who died on the 16th June, 1955, was born on the 9th July, 1875. He had been in poor health for some years.

Born in Lisburn, Northern Ireland, he received his early education at preparatory schools, and his technical education at intermediate and University schools in that town. In 1893 he moved to England to complete his studies at Finsbury Technical College. He gained practical experience at the firm of William Coates and Son, Belfast, from 1895 to 1899, in which year he was appointed Assistant Engineer at the same firm.

In 1901 he moved to London once more to take up an appointment as Testing and Erecting Engineer with R. Waygood and Co., where he was employed on the testing of elevator motors and controllers, including the lifts used on underground railways. In 1904 he was promoted to Assistant Engineer at the Newcastle branch of the company, his work covering the preparation of drawings and tenders for lifts and cranes and the supervision of the erection work.

In 1906 he was appointed as an Engineer with the British Westinghouse Co. at Manchester and in three years rose to the position of Assistant Export Manager, which he occupied until the 1914–18 War. During this period with the Westinghouse Co., he resided for several years in Norway, where he was responsible for the planning of several hydro-electric schemes. In the First World War he served as a Captain in the Royal Flying Corps.

Mr. Wilson went to live in Brora, Sutherland, in 1926 and soon gained the affection of the people there by the active interest he took in their welfare and community activities. He was widely read and his keen native Irish humour was always to the fore. A fine sportsman, he played Rugby and was an amateur boxer in his younger days, and latterly he took up angling at which sport he excelled. He was also captain of Brora Golf Club for several years.

In the Second World War he became an Adjutant in the Sutherland Home Guard, and in 1942 he was appointed County Welfare Officer with the rank of Lieutenant-Colonel, a position he held until he retired three years ago.

Mr. Wilson joined The Institution as an Associate in 1900, and was elected an Associate Member in 1909 and a Member in 1916. J. D. M.

MONOGRAPHS AND PAPERS
published separately this month

Separate monographs and reprints of all papers published in the Proceedings are available at the price of 1s. 3d. each (post free). The inclusive charge for a copy of a paper allocated for reading at a meeting on separate publication and for a reprint of the paper and discussion (as republished in the Proceedings) is 2s. 6d. (post free). This charge is made whether or not the reprint is required, but a reprint alone costs 1s. 3d. as noted above. However, separate copies of a paper allocated for reading are supplied free of charge 10 days before the first meeting at which the paper is to be read, whether in London or in the provinces. If a reprint also is required, a remittance should accompany the request. Reprints of a paper being read at a meeting cannot be issued before the paper and discussion have appeared in the Proceedings, but they should preferably be ordered before or shortly after the paper has been read in London.

In an order, a monograph or a paper can be specified completely by the author's surname and the serial number of the paper. Those who wish to avoid making a separate payment for each monograph, paper, or reprint which they require can obtain books of voucher-labels, price 10s. each, containing 8 vouchers, on application to the Secretary.

A list of papers published in the December issue of Part A of the Proceedings appears under "Contents of the Current Issues of the Proceedings" on page 776, and the serial number of each paper and the month of publication of a digest in the Journal are included. Synopses of both monographs and papers which will be published separately before the next issue of the Journal appear below, and unless otherwise stated, their date of publication is the same as this issue of the Journal. The monographs will be republished in Part C of the Proceedings, and the relevant Part for the republication of a paper is given after the serial number of the paper.

MONOGRAPHS

Attenuation and Permeability of Ferromagnetic Waveguides between 9 000 and 9 675 Mc/s

MONOGRAPH No. 156 R

J. ALLISON, B.Sc.(Eng.), and F. A. BENSON, M.Eng., Ph.D.

Measurements of the attenuations produced by air-filled rectangular waveguides of nickel, mild-steel, mumetal, radiometal and rhometal have been made in the frequency range 9 000–9 675 Mc/s. The permeabilities of the materials have been determined from these measurements and a knowledge of the roughness and resistivity of each waveguide internal surface. The effects of temperature on the h.f. permeability, and of superimposing a steady magnetic field on the h.f. one, have also been studied.

The Theory of Third-Harmonic and Zero-Sequence Fields

MONOGRAPH No. 157 U

G. H. RAWCLIFFE, M.A., D.Sc., and B. C. McDERMOTT, B.Sc.(Tech.)

The monograph first reviews existing information about third-harmonic fields, mainly published previously in piecemeal fashion, and then adapts and extends it to modern form for use in symmetrical-component theory as applied to machines. This theory has provided the basis for a very successful 3 : 1 pole-changing machine which has been described elsewhere, and the monograph includes a number of test results which verify that the theory of third-harmonic fields given here is essentially sound.

Mutual Heating in Transmitting-Valve Filament Structures

MONOGRAPH No. 158 R

W. J. POHL, M.Sc.

The paper deals with heat radiation characteristics of filament structures in the region of 2 000° K, such as are used in transmitting valves. It shows how the effects of mutual heating between the individual elements may be calculated, and includes a set of universal curves which enable the results to be readily applied to structures of cylindrical form.

PAPERS

An Evaluation of Two Rapid Methods of Assessing the Thermal Resistivity of Soil

PAPER No. 1942 M; PART A

M. W. MAKOWSKI, Dipl.Ing., and K. MOCHLINSKI, Dipl.Ing.

The paper evaluates two methods recently proposed for the rapid assessment of the thermal resistivity of soil *in situ*, with special application to the assessment of cable ratings.

Brief consideration is given to the factors determining the thermal resistivity of the soil, i.e. its composition, compactness and moisture content, and to the present standard method of measurement by buried spherical or cylindrical heater.

The basis of the so-called transient-needle method is then set out. Theory, errors due to departure from ideal conditions, and practical application are considered.

A method based on soil sampling is next discussed. After critical considerations of the underlying theoretical and practical work by Gemant, Kersten and Mickley in the United States, a nomogram is introduced by means of which the thermal resistivity of sand-clay mixtures of known physical characteristics may be simply determined. The practical application of the two rapid methods to field measurements is described, and results obtained by the various methods compared.

Finally, the new methods are discussed and compared with that using the static buried heater.

The Use of Cyclic Permuted Codes in Relay Counting Circuits

PAPER No. 1944 M; PART B

G. C. TOOTILL, M.A., M.Sc.

Relay counting circuits to meet conventional requirements are considered. If only one relay is allowed to move at the start and at the finish of each input pulse, it is shown that the minimum total number of relays is required. The sequence of states of the circuit can thus be characterized by a cyclic permuted code, this term being used in a more general sense than is customary. Circuits using the reflected binary cyclic permuted code, and means of adapting them so that the number of states in the counting cycle is not restricted to a power of two, are given. These have the disadvantage (shared by most relay counters) of different relays wearing at different

rates. Basically different cyclic permuted codes are given, for the particular cases of four digits and five digits, resulting in more even wear. No code with this property has been found, however, which applies to any number of digits.

Reading of Magnetic Records by Reluctance Variation

PAPER No. 1946 M; PART B

T. KILBURN, M.A., Ph.D., D.Sc., G. R. HOFFMAN, B.Sc., Ph.D., and P. WOLSTENHOLME, B.Sc.

The paper describes a method of reading information recorded on a magnetic medium, in which the velocity of the medium can have a wide range of values including zero. Read signals are obtained by varying the reluctance of the reading head. With a head constructed according to this principle 50 binary digits per inch have been read from magnetic tape.

The Theory and Characteristics of the 3 : 1 Pole-Changing Induction Motor

PAPER No. 1951 U; PART A

T. H. BARTON, Ph.D., O. I. BUTLER, M.Sc., and H. STERLING, B.Sc.

It is shown that the primary winding of a 3-phase induction motor, having say, p poles, may be reconnected to constitute a $3p$-pole winding of two or three symmetrical phase windings, the latter being little known, and the former being an entirely new type of pole-changing connection with considerable practical possibilities. Thus, a synchronous speed of one-third the normal value is obtained. It is noted that reconnection as an np-pole winding is possible, where n is any odd integer.

It is shown also that the performance characteristics of the motor for the $3p$-pole connection can be deduced satisfactorily from the design data of the machine, and that the single machine can be designed to provide characteristics which are comparable with those provided by two separate single-speed machines of standard design.

In addition, for the first time so far as the authors are aware, an attempt is made to predict the performance of an induction motor from design data when the performance is appreciably affected by the presence of pronounced space harmonics of magnetomotive force. A satisfactory prediction is possible only when the secondary parameters include the "skew leakage reactance" component, which appears to have been completely ignored in the published work of Great Britain. It is the most important component of the secondary leakage reactance for the harmonics of space m.m.f., and may quite well be the most important component for the fundamental space m.m.f. of squirrel-cage induction motors having a full-pitch primary winding and normal skew of the rotor bars.

Digital Computers and the Load-Flow Problem

PAPER No. 1957 M; PART B

J. M. BENNETT, Ph.D.

In distribution networks, the power generated or consumed at the various busbars is usually known, together with the voltage of one busbar and a specification of how the system losses are supplied; the information most useful to the power engineer is a list of the corresponding current flows and voltages throughout the network.

The paper sets out a technique for carrying out this work with an automatic digital computer, with special reference to useful programming devices. The technique was developed on the Manchester University computer.

The Development of a New 3 : 1 Pole-Changing Motor

PAPER No. 1958 U; PART A

G. H. RAWCLIFFE, M.A., D.Sc., and B. V. JAYAWANT, B.Eng.

The paper describes the development of a new 3 : 1 pole-changing induction motor with one 3-phase winding only, in which the performance and rating of a given machine frame for each speed are in all respects nearly equal to the best values that could be obtained from the same frame if it were wound in a normal manner for that speed only.

A simple pole-changing winding which gives a high performance for a 2 : 1 speed ratio is well known and widely used, and it seems probable that the development of a winding giving even better performance for a 3 : 1 speed ratio will find many applications, once its existence is generally known. It is believed that this is the first time a satisfactory winding of this type has been devised, although several comparable but unsatisfactory variants have previously been proposed.

A Bridge for the Measurement of Permittivity

PAPER No. 1963 M; PART B

A. M. THOMPSON, B.Sc.

A description is given of a null method for the measurement of the complex permittivity of dielectrics. The direct admittance of a capacitor with the sample as dielectric is measured as a complex capacitance, the two components being indicated directly on two 3-terminal variable air capacitors. In addition to these the bridge network comprises transformer ratio arms and an amplifier whose output voltage is in quadrature with that of the transformer. The bridge operates at ten fixed angular frequencies from 30 to 10^6rad/sec.

BRITISH NUCLEAR ENERGY CONFERENCE

The following paper will be read at a meeting of the Conference on the 18th January, 1956 (see page 775). Advance copies of it will be available from the Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1; applications for these should include a stamped addressed label or envelope (preferably 9 in × 6 in)

The Use of Sodium and Sodium-Potassium Alloy as a Heat-Transfer Medium

W. B. HALL, B.Sc.(Eng.), and T. I. M. CROFTS

The nuclear reactor has stimulated the search for a heat-transfer medium capable of operating efficiently over a wide temperature range, and in this connection liquid metals have received much attention. The paper discusses briefly the relative merits of various metals, such as the alkali metals and mercury, which, having low melting points, are suitable for general application as heat-transfer media. The experimental work described was directed mainly along two lines; first, measurements of heat-transfer coefficients, and secondly, the development of handling techniques, such as pumping, flow measurement, and level control. Of the eight liquid metal circuits which have been built and operated during three years of investigation, three typical examples are discussed.

As a result of the work the authors conclude that the handling problems of sodium and sodium-potassium alloy can be solved by well-established techniques, and that these metals could be applied to a wide range of heat-exchange problems.

TECHNICAL PUBLICATIONS

BRITISH STANDARDS AND CODES OF PRACTICE

The Secretary has been asked to draw attention to the following publications, copies of which can be obtained from the British Standards Institution, 2 Park Street, London, W.1. The prices given for each Standard are post free.

COMPONENTS AND FILTER UNITS FOR RADIO INTERFERENCE SUPPRESSION (B.S. 613: 1955). 6s.

This is a further revision of a Standard (B.S. 613) first published in 1935, and revised in 1940, and its publication is intended to coincide with the operation from the 1st September, 1955, of statutory regulations controlling interference from electric motors and refrigerators (S.I. 291 and 292: 1955).

The Standard covers suppression components and filter units for use on apparatuses operating at normal voltages (e.g. 230 volts), and with ratings up to 7 kVA. As the title implies, the new Standard does not deal with suppression components or units for internal combustion engines or for traction, marine or other special purposes. In connection with these uses reference should be made to the other Standards dealing with the suppression of radio interference such as B.S. 827: 1939, B.S. 833: 1953 and B.S. 1597: 1947.

The main differences between the revised and original Standards are the introduction of requirements governing complete filter units, the enlargement of the section dealing with capacitor requirements and tests, and the introduction of clauses dealing with neon-sign suppression-inductors.

The general principles underlying the use of suppression components, which were formerly covered in appendices to the 1940 edition, have now been extended and published separately as a Code of Practice (C.P. 1006: 1955), "General Aspects of Radio Interference Suppression," which is intended primarily as a working guide to the dealer or service engineer who is called in to fit suppressors to offending apparatus.

PROJECTION WELDING OF LOW CARBON STEEL SHEET AND STRIP (B.S. 2630: 1955). 2s. 6d.

This is one of the process Standards in the comprehensive series for the resistance welding of steel. It specifies the general requirements for the projection welding of low-carbon steel sheet and strip under normal conditions of manufacture and service.

DRAFTING SPECIFICATIONS BASED ON LIMITING THE NUMBER OF DEFECTIVES PERMITTED IN SMALL SAMPLES (B.S. 2635: 1955). 2s. 6d.

This publication is intended chiefly for the assistance of those concerned in the drafting and use of clauses in specifications based on a statistical analysis of the results of sampling, particularly with small samples. The information given can be applied to individual consignments of goods, or to the examination of successive consignments to provide information as to the general level of quality maintained by the producer. The smaller the sample, the more difficult it is to differentiate between consignments differing greatly in quality. Nevertheless, the routine use of such samples tested during production can serve to indicate fluctuations in quality and lead to the effective control of processes, and to the manufacture of products of satisfactory quality.

CODE OF PRACTICE ON INTERFERENCE SUPPRESSION (C.P. 1006). 10s.

Publication of the British Standard Code of Practice on the general aspects of radio interference suppression is of particular interest in view of the fact that statutory regulations*

* S.I. 1955, No. 291: The Wireless Telegraphy (Control of Interference from Electric Motors) Regulations, 1955, and S.I. 1955, No. 292: The Wireless Telegraphy (Control of Interference from Refrigerators) Regulations, 1955, respectively.

on the control of interference from electric motors and from refrigerators come into operation on the 1st September, 1955. The new Code has been prepared mainly as a guide for dealers, service engineers and others concerned with the suppression of interference with radio and television reception.

Suppression techniques applicable to the long and medium wavebands, and to the B.B.C. television band (41–68 Mc/s) are dealt with in the Code. Although it is expected that these techniques will also be suitable for suppression over the v.h.f. (sound) and alternative television bands (87·5–100 Mc/s and 174–216 Mc/s), there is insufficient experience in the practical use of suppressors at these frequencies to allow of firm recommendations.

For ease of reference, the Code is divided into seven separate sections, the first one including definitions of terms used in suppression practice.

Section 2 discusses the origin and nature of interference. It explains how radio-frequency noise is generated, and details the various ways in which it may be propagated to the receiving installation.

Section 3 deals with the recognition, tracing and assessment of radio noise. In Section 4 the steps which can be taken at the receiving end to reduce susceptibility to interference are dealt with.

Section 5, which deals with suppression of interference at the source, covers not only the application of suppressors to existing apparatus, but also makes recommendations to designers of equipment which will render that equipment inherently less liable to cause interference. The features which affect the choice and design of suppression components are covered in Section 6.

Section 7 deals with the all-important safety aspects of the use of suppression components. Recommendations are given on the maximum nominal capacitance which may safely be used for suppression purposes with various modes of connection, and emphasis is laid on the need for the correct fitting of suppressors and correct wiring.

In the section devoted to the practical applications of suppressors, examples are given of different types of suppression units which have been found necessary and satisfactory for the suppression of interference from various types of device in both the broadcast and television bands.

B.S.I. SALES OFFICE IN BIRMINGHAM

Through the co-operation of the Birmingham Chamber of Commerce, the British Standards Institution has now opened a sales office in the headquarters of the Chamber at 95 New Street, Birmingham 2.

SOME RECENT BOOKS

S. BUTTERWORTH

ELECTRICAL CHARACTERISTICS OF OVERHEAD LINES

ELECTRICAL RESEARCH ASSOCIATION. 238 PP. 15 CHARTS. £2 2s.

Mr. Butterworth is well known for his work on behalf of the Electrical Research Association on the mathematical aspects of overhead lines, and from time to time the E.R.A. has published his investigations in the form of reports with which many engineers are familiar. However, as a number of isolated documents they are not in the most convenient form, and it is gratifying to find that the E.R.A. has now published a compilation of Mr. Butterworth's past work in textbook form, thereby considerably enhancing its general usefulness to those concerned with overhead lines, particularly the higher-voltage type.

The author deals with the subject both mathematically and by means of tabulated data and nomograms (alignment charts) relating to the practical parameters of overhead lines as constructed in Great Britain. The book thus appeals to two classes of reader, those who wish to study the theoretical basis of overhead-line design problems, and the very much larger body of practising engineers who are anxious to obtain relevant data for a particular type of line as quickly and simply as possible. Throughout his work the author has had the requirements of the second class of reader clearly in view.

The broad plan which the author follows is to deal fully with the theoretical aspect, working from accepted basic formulae to final mathematical solutions, using both rigorous and approximate methods. He then uses his final formulae to evaluate solutions for a wide range of conductors and types of line. The results of these computations are given in the form of tables or nomograms.

The opening chapters deal with the resistance of conductors made of different materials, e.g. copper, aluminium, steel-cored aluminium, and steel. The succeeding chapters form a dissertation on the inductance, reactance, capacitance and susceptance of single-phase lines, and a discussion of the related characteristics of 3-phase lines, under both balanced and unbalanced loading conditions. Corona losses, multiple (or bundle) conductor systems, and voltage regulation form separate chapters, and there is a brief treatment of current ratings of conductors.

A particular defect in using the book is the absence of either an index or a glossary of terms and symbols. The bibliography, however, is comprehensive and as up to date as could reasonably be expected. It is a pity that in addition to dealing with corona losses the author has not given any information on other secondary losses, such as eddy losses in clamps and fittings of different materials. The work would also have been more comprehensive if the author had touched on the inductance of steel towers and the calculation of conductor-tower capacitance, as authoritative data on these matters are often needed in dealing with lightning-fault investigations. Possibly future editions will deal with these criticisms and will include in the tables and charts the data on conductor sizes and dispositions which have been standardized for the Grid in this country since the original publication of the author's work in report form. While the author's formulae enable the necessary calculations to be made, tabulated data, particularly in respect of twin 0·175 in diameter and single and twin 0·4 in diameter steel-cored aluminium conductors, would be invaluable since the calculations are laborious.

These criticisms merely point out small blemishes in a master painter's brushwork, and it would be true to say that no engineer engaged on design of overhead transmission lines, whether he is studying a mathematical theory or is concerned with the practical design of a high-voltage line, can afford to dispense with such an excellent desk reference book.

H. CARPENTIER

LIGNES ÉLECTRIQUES T.H.T.

PARIS: EYROLLES. 250 PP. £4 18s. APPROX.

This book deals with the mechanical design and construction of overhead lines and is the only major work on this subject, or one of a very few, to be published within the last quarter of a century. It is directed primarily to the engineer responsible for the planning and design of a line, the electrical requirements having previously been settled. The method of treatment is, however, such as to make it also valuable to advanced students working in this rather specialized field.

The first part of the book deals with calculations relative to composite conductors, such as those involved in the sharing of the tension between, and the evaluation of the best relative cross-sectional areas of, the two components, and this is followed by sag-temperature calculations. Neither the hyperbola nor the ellipse, for the representation of the curve taken up by a suspended conductor, is easily amenable to calculation, and, since Truxa's algebraic methods are suitable for routine design-office procedure, the parabola is used. Conductor vibration is referred to only very briefly.

The study of supports is naturally confined to the lattice-steel tower, and includes the conventional methods of structure analysis and a full investigation into the design of foundations. The latter are not amenable to rigorous mathematical treatment but five methods of calculation are discussed. Those of Fröhlich and Burklin are the most comprehensive, but the French method of Valensi is simpler and is stated to have given adequate results over the last thirty years.

Five appendices give full calculations relating to conductor tensions and to the design of four different types of tower. A final short section gives an interesting and valuable account of construction procedure, including a number of very good photographs.

The major part of the book, which is devoted to mechanical considerations, is excellent, but the author seems less sure in his brief references to electrical matters; for instance, while Peek's corona-loss formulae are quoted, no reference is made to more recent work on h.v. lines or to the use of grouped conductors. Similarly the mechanical strength of insulators and their supports is fully discussed, but the short section on electrical characteristics makes no reference to recent work, e.g. by Forrest on insulator development and by Golde on lightning flashover. There is a comprehensive table of contents but the book suffers from lack of an index. An eleven-page bibliography covering the last forty years and referring chiefly to European literature is included.

For this work the author was made the first recipient, in

February, 1955, of the *Prix du Livre Technique* awarded by La Fédération Nationale des Travaux Publics. The very pleasant style of writing, together with the mass of valuable theoretical and practical data that is presented, should make any reader feel that the award was fully justified.

ALAN E. CRAWFORD
ULTRASONIC ENGINEERING

LONDON: BUTTERWORTH. NEW YORK: ACADEMIC PRESS. 354 PP. £2 5s.

The book consists of 13 chapters which are divided under three general headings: Theory (Chapters 1 and 2), Generation (Chapters 3–6) and Applications (Chapters 7–13). The term *ultrasonic* is used in this book to describe "a vibratory wave of a frequency above that of the upper frequency limit of the human ear; it generally embraces all frequencies above about 16 kc/s."

As the reader may deduce from the ratio of chapters appearing under the three general headings, the book is mainly concerned with generation and applications. The author has been employed in the development and exploitation of high-power ultrasonics for industrial purposes, and the last two sections demonstrate his familiarity with the characteristics and design of industrial equipment which is available or which has been proposed. The section on theory, which deals with ultrasonic waves and cavitation, shows the author on less firm ground. Indeed, Chapter 1 gives the impression of having been put together rather hurriedly, as an afterthought, for it is marred by a certain looseness of statement which would often prove confusing to those not already acquainted with the nature of mechanical waves in solids, liquids and gases. "Theory" is something of a misnomer for a section in which working formulae are produced with little or no discussion of the fundamental properties and processes from which they are derived. In fact the remainder of the book is certainly no less "theoretical." In dealing with generation and application, however, the author is much surer, and these two sections form a valuable record of industrial ultrasonics, in which frequent reference is made to original sources in English, French and German for those who require even more detail.

The section concerning generation contains chapters on piezo-electric transducers, magnetostriction transducers and generators, jet generators and electromagnetic transducers. These chapters contain descriptive matter on the various generators, and practical considerations are kept well in view with the provision of numerous response curves, electrical circuit diagrams and information on design details.

The section dealing with applications contains chapters on precipitation and agglomeration, emulsification and dispersion, chemical applications, metallurgical applications, coating of metals, biological and medical applications and ultrasonic instruments and control gear. Here, almost the whole field of industrial application is effectively reviewed, and the section demonstrates the very wide variety of problems which ultrasonics can help to solve.

The book can be recommended to anyone who is concerned with ultrasonic applications or with the possibility of applying ultrasonics to specific problems. The last section may also make interesting general reading for other engineers who wish to learn of developments in the subject without becoming too deeply involved in the specialized background.

G. GOUDET
ÉLECTRONIQUE INDUSTRIELLE

PARIS: EYROLLES. 635 PP. £5 12s. APPROX.

In view of the title chosen, it is rather surprising to find that only a small part of the book is devoted to industrial applications. Indeed, of the 26 chapters, the first twenty constitute a very thorough textbook of electronic theory, which could well form the basis of a course for students intending to go on to almost any branch of the subject.

Part 1 deals with general circuit theory, the five chapters considering, in turn:

Units; the general laws of circuits with lumped constants and methods of mathematical analysis including development in Fourier series and Fourier and Laplace transform processes; the theory of circuit elements (resistors, inductors and capacitors); transient and steady state behaviour of common circuits, including the ideal transformer; transmission lines, impedance matching and standing waves.

The four chapters of Part 2 cover:

The atomic structure of solids, electron distribution and energy levels from the point of view of wave mechanics, with applications to metals, insulants and semi-conductors, thermionic emission, work function and contact potential; hot-cathode tubes; gas-filled tubes; and power supply systems for electronic tubes.

In these four chapters, practical construction and characteristics are described and some introductory consideration is given to amplification. This subject is enlarged upon in Part 3, which has chapters on:

Non-selective amplifiers (audio and video) including correction of high- and low-frequency response; selective amplifiers; feedback amplifiers, stability (Nyquist's, Bode's, and Routh and Hurwitz's criteria), distortion, self-oscillation and noise; and transistors and magnetic amplifiers.

The three chapters of Part 4 cover sinusoidal and non-sinusoidal oscillators; amplitude and frequency modulation and demodulation. In Part 5 the author considers the general laws of electron optics and their application to cathode-ray tubes; the electron microscope; and the mass spectrometer.

The industrial applications covered by the six chapters of Part 6 are:

Induction and dielectric heating; photo-electric cells and their applications to photometry, sound reproduction, infra-red telephony, etc.; ultrasonics and its use in underwater sounding and communication, testing of materials, etc.; the general theory of servo mechanisms; components of servo mechanisms, including reference and measuring elements, amplifiers, servo motors and data transmitters; and, finally, examples of servo mechanisms for artillery fire control, motor speed control, temperature control and stabilization of d.c. voltages.

The treatment is, generally, very thorough, but the proof reader has allowed a number of minor errors to slip through. Most of these, such as the incorrect numbering of two Figures, and the omission of a minus sign, will be fairly easily detected by the engineer or a student reading the text carefully. In the discussion of gas-discharge tubes, the author mentions an accumulation of positive ions at the boundaries of the plasma without having defined the latter. There are also a few omissions tending to mar the "up-to-date-ness" of the book. In the section on driver stages for push-pull amplifiers, for example, there is no mention of the "see-saw" paraphase amplifier, and in the chapter on demodulation, the ratio detector is similarly neglected.

Despite these defects, the book may be recommended to the practising engineer, as a useful reference book and refresher course, and to the advanced student, for whom it should provide a thorough grounding in the subject.

* *Denotes that the publication is also in the Lending Library. The publications cannot be bought through The Institution; the publishers and the prices are given only for the convenience of members.*

LIBRARY ACCESSIONS

BOOKS

ADDISON, H. 621.6

Centrifugal and other Rotodynamic Pumps

2nd ed. London, Chapman and Hall, 1955. pp. x, 530. 23 × 15 cm. £2 10s.

A comprehensive work dealing with principles, design and construction, performance, installation and operation of centrifugal pumps and allied machinery.

BROGLIE, L. DE 539

Physics and Microphysics

London, Hutchinson, 1955. pp. 286. 22 × 14 cm. 21s.

A history of the development of the theory of the atom. It describes the achievements of Rutherford, Planck, Bohr, Heisenberg and others including the author's own discoveries. There is a chapter describing scientific discoveries in electricity in the 18th and 19th centuries and consequent applications, and others sketching the history of radio.

HERSHBERGER, W. D. 621.392

Principles of Communication Systems *

New York, Prentice-Hall, 1955. pp. xiii, 253. 22 × 15 cm. £2 13s. 6d.

Discusses the signals used in various branches of communication and their spectra, elementary information theory, noise, methods of modulation, and the characteristics of communication channels.

KEITZ, H. A. E. 535.24

Light Calculations and Measurements *

An introduction to the system of quantities and units in light-technology and to photometry

Eindhoven, Holland, Philips' Technical Library, 1955. pp. xvi, 413. 23 × 16 cm. £2 12s. 6d.

A practical book on the measurement of light and on the associated calculations. This book will be reviewed in a future issue.

LANGSDORF, A. S. 621.313.3

Theory of Alternating-Current Machinery *

2nd ed. New York, McGraw-Hill, 1955. pp. xix, 666. 24 × 16 cm. £3 4s.

Deals with power transformers, machines, and mercury-arc rectifiers and inverters. The rationalised M.K.S. system of units is used.

PARKER, M. E. 621.316.97

Pipe Line Corrosion and Cathodic Protection

Houston, Texas, Gulf Publishing Co., 1954. pp. vi, 104. 20 × 13 cm. 24s.

A practical work describing techniques used by the author in the field and which may well be found useful by others concerned with corrosion prevention. Deals with soil resistivity surveys, potential surveys, measurements, and some design considerations for cathodic protection systems.

POWEL, C. A. 621.31

Principles of Electric Utility Engineering *

London, Chapman and Hall, 1955. pp. viii, 251. 24 × 15 cm. £2 8s.

Based on a series of lectures to non-specialist students to arouse their interest in the subject, this book reviews briefly the whole field of power system engineering.

ROSE, W. N. 51

Mathematics for the Engineer. Part I. Including elementary and higher algebra, mensuration and graphs, and plane trigonometry 9th ed. London, Chapman and Hall, 1955. pp. xiv, 527. 22 × 14 cm. 21s.

TURNER, R. P. 621.314.7

Transistors. Theory and practice *

New York, Gernsback Publications, 1954. pp. 144. 22 × 14 cm. 16s.

Explains in simple language semi-conductor theory, transistor characteristics, and equivalent circuits. Then discusses uses as amplifiers, oscillators, triggers and switches. There is a final chapter on tests and measurements.

WOODSON, W. E. 621:744

Human Engineering Guide for Equipment Designers *

Berkeley, University of California Press, 1954. pp. 260 approx. 20 × 26 cm. 26s.

A detailed study of the physical measurements and the movements of the human body on which can be based the design of equipment and work space so that operators can work efficiently. Covers seeing, hearing and operating of knobs, levers, wheels, etc., and standing, sitting and various positions.

OTHER PUBLICATIONS

ASSOCIATION POUR L'ENCOURAGEMENT A LA RECHERCHE AÉRONAUTIQUE

Aéro-Électronique. First International Congress, Paris, 1953–1954. Paris, Dunod, 1955. pp. xiv, 846. 28 × 19 cm. About £7 12s.

BRITISH ELECTRICITY AUTHORITY

Seventh Report and Statement of Accounts for the Year ended 31st March, 1955. (Also the reports of the fourteen Area Boards.) London, H.M. Stationery Office, 1955.

CONVENTION ON ELECTRIC TRACTION BY SINGLE-PHASE CURRENT AT INDUSTRIAL FREQUENCY

Documents 1–16. Papers read at the Convention held in Lille from the 11th to the 14th May, 1955

Paris, Société Nationale des Chemins de Fer Français, 1955.

FEDERATION OF BRITISH INDUSTRIES

Restrictive Business Practices and the Public Interest

London, Federation of British Industries, 1955. pp. 16. 22 × 14 cm. 1s. 3d.

INSTITUTION OF PRODUCTION ENGINEERS

The Automatic Factory—What Does It Mean? Report of the Conference held at Margate, 16th to 19th June, 1955 *

London, Institution of Production Engineers, 1955. pp. 228. 29 × 22 cm. 25s.

INTERNATIONAL SCIENTIFIC RADIO UNION

Proceedings of the XIth General Assembly held in The Hague from August 23rd to September 2nd, 1954. Volume 10. Part 3. Commission 3 on Ionospheric Radio

Brussels, U.R.S.I., 1954. pp. 194. 24 × 16 cm.

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SUMMARY OF CONTRIBUTIONS RECIVED TO 25TH NOVEMBER, 1955

	No. of Contributors	£	s.	d.
£1 000 and over	6	6000	0	0
£100 to <£1 000	29	6386	3	0
£5 to <£100	771	8380	19	5
£2 to <£5	1829	5044	16	8
Under £2	17667	9389	19	4
		£35201	18	5

APPOINTMENTS AND NOMINATIONS

WIRING REGULATIONS COMMITTEE

On the nomination of the Ministry of Labour and National Service, the Council have appointed Mr. S. J. Emerson, M.ENG., ASSOCIATE MEMBER, to serve on the above Committee in place of Mr. F. H. Mann, MEMBER.

FIRE OFFICES' COMMITTEE, FIRE PROTECTION ASSOCIATION—COMMITTEE ON RECOMMENDATIONS FOR THE USE OF ELECTRICITY IN INDUSTRY

The Council have nominated Mr. Forbes Jackson, MEMBER, to serve as their representative on the above Committee which is to prepare recommendations for the safe use of electricity in industry with particular regard to fire hazards.

CODES OF PRACTICE COMMITTEE FOR ELECTRICAL ENGINEERING (ELCP/–) CODES OF PRACTICE COUNCIL: CODE DRAFTING COMMITTEE ON THE MAINTENANCE OF INSULATING OILS

The Council have nominated Mr. A. W. Stannett, B.SC.(ENG.), ASSOCIATE MEMBER, to serve as their representative on the above Committee in place of Dr. J. S. Forrest, D.SC., M.A., MEMBER.

GOVERNING BODY OF THE COLLEGE OF AERONAUTICS, CRANFIELD

The Council have nominated Mr. T. E. Goldup, C.B.E., VICE-PRESIDENT, to serve as their representative on the above body in place of Mr. G. S. C. Lucas, O.B.E., MEMBER.

THE SUMMER MEETING NEXT YEAR

HEADQUARTERS AT BIRMINGHAM

As briefly announced last month, The Institution's Summer Meeting in 1956 is to be held in the South Midland Centre from June 25th to 29th, and the headquarters will be in Birmingham. Within the Centre some of the largest electrical engineering manufacturers have their works, but, in addition to these, there are more than a thousand trades in Birmingham alone, all of which are users of electricity.

One of the objects of this Meeting will be to give members an opportunity of seeing all facets of the electrical industry from generation to utilization of electricity. The generation side will be seen at Hams Hall, which on completion of the Hams Hall C power station will have the largest plant capacity of any one site in Great Britain.

Contrary to general opinion, the Midlands are not chiefly an area of dirty, drab industrial buildings and there is much beautiful country to be seen: after a tour of the English Electric works at Stafford on June 26th, those on the Meeting will be able to explore the delightful country of Shropshire. In addition to this jaunt, a trip will be made to the vale of Evesham in Worcestershire and Warwickshire, after a visit to the British Thomson-Houston works at Rugby.

No stay in the Midlands would, of course, be complete without including the Shakespeare country and the Stratford Memorial Theatre, and arrangements have been made for a large party to visit Stratford on the evening of June 27th to see a Shakespeare play.

Those planning the Meeting programme well appreciate that ladies may not always share members' enthusiasm for electrical plant and machinery; the ladies on the 1956 Summer Meeting will have the opportunity to visit manufacturing houses of fine pottery, glass-ware, gloves and furniture.

For those members more interested in the utilization of electricity, a series of visits will cover such widely varying uses as chemical manufacturing and electro-medicine.

"All work and no play . . ." is a saying of which The Institution is very conscious and to this end there will be an excellent series of social events besides the visit to Stratford, terminating with an informal evening at the Botanical Gardens, Birmingham.

It is hoped to send members full details of the Meeting and application forms next month.

A HOLMES MAGNETO-ELECTRIC GENERATOR

The Institution has in its possession one of the Holmes magneto-electric a.c. generators of 1867 that were installed in Souter Point Lighthouse, near Sunderland, in 1871. The Council would be pleased to present this machine to any museum or other organization that would display it to the public. Some information about these generators, including their approximate dimensions and a photograph of the one in the Science Museum, was given on page 284 of the May, 1955, issue of the *Journal*. Any member who knows of a museum or other organization that would be interested in possessing a Holmes generator is asked to communicate with the Secretary of The Institution.

COLONEL JOHN BY, R.E.

CANADIAN MEMORIAL TO THE FOUNDER OF OTTAWA

On the 5th October, 1955, through the initiative of the Engineering Institute of Canada, a fountain in memory of Lt.-Col. John By was unveiled in Ottawa by Dr. J. Heartz, President of The Institute. A cable of greetings from the President and Council of The Institution was read at a luncheon held to mark the ceremony.

Colonel By was an Englishman born in 1781. He was commissioned in the Royal Engineers and spent much of his service career in Canada. In 1826 he was given the difficult task of constructing the Rideau canal from the St. Lawrence to Lake Ontario, and made his headquarters at a spot near the junction of the Ottawa and Rideau rivers. This place became known as Bytown, but the name was changed to Ottawa in 1855. The memorial fountain, built in Scottish red granite and designed by Sir Charles Barry, stood in Trafalgar

Square for over 100 years; on its removal in 1948 it was given to the National Gallery of Canada, who in turn made the fountain available to the Engineering Institute of Canada.

Colonel By, who died in 1836, is buried in the churchyard of Frant, Sussex, and there is also a memorial tablet to him in the church. Two years ago the three major British Engineering Institutions were pleased to put his grave into good repair, and in the same year the Mayor of Ottawa and the President of the Engineering Institute of Canada visited the grave while in England for the Coronation.

SUBSCRIPTIONS TO THE PUBLICATIONS OF OTHER ENGINEERING INSTITUTIONS

We remind members of the reciprocal arrangements whereby they can obtain the technical periodicals of other Engineering Institutions and Societies at the specially reduced rates listed below:

	£	s.	d.
Institution of Civil Engineers (*Proceedings*)			
Part I	1	0	0
Part II		10	0
Part III		10	0
(Single issues of any Part, 3s. 6d.)			
Institution of Mechanical Engineers:			
Chartered Mechanical Engineer and separates of *Proceedings*	4	16	0
Chartered Mechanical Engineer and separates and bound volumes of *Proceedings* and Automobile Division *Proceedings*	6	18	6
Chartered Mechanical Engineer and bound volumes of *Proceedings* and Automobile Division *Proceedings*	6	8	6
Self-binding case for the copies of *Chartered Mechanical Engineer*		12	0
American Institute of Electrical Engineers:			
Electrical Engineering	2	10	0
Transactions	3	12	6
Both the above publications	4	7	6
Communication and Electronics	1	2	0
Application and Industry	1	2	0
Power Apparatus Systems	1	2	0
Associazione Elettrotecnica Italiana:			
L'Elettrotecnica	1	15	0
Alta Frequenza		17	6
Dansk Ingeniørforening	1	5	0
Engineering Institute of Canada	1	9	0
Institution of Engineers, India		18	0
Institute of Physics:			
British Journal of Applied Physics	2	0	0
Journal of Scientific Instruments	2	10	0
Both the above publications*	4	10	0
Institute of Radio Engineers, America:			
Proceedings	3	5	0
Transactions of the 21 Professional Groups	27	0	0
Transactions of any single Professional Group	3	1	0
Institution of Engineers, Australia	1	14	0
Koninklijk Instituut van Ingenieurs	1	10	0
New Zealand Institution of Engineers		14	6
Société Belge des Électriciens	1	4	6
Société Française des Électriciens	2	8	0
South African Institute of Electrical Engineers	2	1	0
Svenska Teknologföreningen	1	15	6

Members' subscriptions must be transmitted through the Secretary of The Institution of Electrical Engineers, except those for the publications of The Institution of Mechanical Engineers, which should be sent to the Secretary of that Institution, and those for the *Proceedings* of The Institution of Civil Engineers, which should be sent to one of the following agents:

Sir Isaac Pitman and Sons, Ltd.: The Book Centre, North Circular Road, Neasden, London, N.W.10; Little Collins Street, Melbourne, Australia; Pitman House, 381–3, Church Street, Toronto, Canada; 27, Becketts Buildings, President Street, Johannesburg, South Africa; Pitman Publishing Corporation, 2, West 45th Street, New York; A. H. Wheeler and Co., Hornby Road, Bombay; 11, Clive Street, Calcutta, and 115, Elgin Road, Allahabad.

* The reduced rates now apply to these two publications together.

CONFERENCE ON LUBRICATION AND WEAR, OCTOBER, 1957

The Institution of Mechanical Engineers is arranging a Conference on Lubrication and Wear to be held from the 1st to 3rd October, **1957**, for which it is hoped to obtain papers covering the whole range of the subject; the papers will be arranged in groups and there will be a full discussion at each session. It is intended that some papers will summarize well-established aspects of the subject, and others will cover aspects that are developing rapidly.

The Institution of Mechanical Engineers welcomes papers by both members and non-members of that Institution to be considered for inclusion in the Conference. Intending authors should submit a brief synopsis of the papers they have in mind before the 1st April, **1956**; they should note that each paper will probably be limited to a maximum length of 3000 words, plus illustrations.

Further information about the Conference may be obtained from the Secretary, The Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1.

BRITISH ELECTRICAL POWER CONVENTION

TORQUAY, 23RD–29TH MAY, 1956

The Eighth British Electrical Power Convention will be held at Torquay from the 23rd to 29th May, 1956, under the Presidency of Sir John Dalton.

The theme of the Convention will be "electricity and transport." Papers by eminent persons in the electricity, transport and manufacturing industries will deal with the many aspects of the use of electricity in transport, such as Railway Modernization in Great Britain, Battery-electric Vehicles, Trolley-buses, Signalling, Electricity in Shipping and Aircraft, etc.

Members who wish for further information about the Convention should write to the Secretary, British Electrical Power Convention, Winsley Street, London, W.1.

ELECTRIC TRACTION IN FRANCE

The Secretary has received a set of sixteen papers read at the French Convention on Electric Traction by Single-Phase Current at Industrial Frequency, held in Lille from the 11th–14th May, 1955. The papers, which are printed in English, may be consulted in the Library of The Institution. They include a survey entitled "Evolution in electric traction equipment" by H. Parodi, a comparison—most germane to Britain at the present time—of different systems of electric traction by M. Garreau, a discussion of the use of power from the national Grid for traction purposes by J. Gastine, two papers on catenaries by J. Walter and A. Crepet, a paper entitled "Coexistence of Alternating Current Electrified Railways and Telecommunication Circuits" by J. Collet, an account of 50 c/s substations by M. Bernard, and five papers

on locomotives and motor stock. Two of the last group of papers are by Monsieur F. Nouvion, who, with Monsieur Garreau, read papers on the French 50c/s electrified railways before The Institution in London in May, 1954; one of Monsieur Nouvion's present papers is entitled "The development of the 50c/s single-phase locomotive in the near future."

These papers thus form a very complete record of present practice in, together with some account of future plans for, the French 50c/s railway electrification schemes.

CONVENTION ON CONTROL ENGINEERING

HEIDELBERG: SEPTEMBER, 1956

A convention to consider the "Importance of Theory in the Application of Control Engineering" will be held in the new University of Heidelberg, Germany, from the 24th to 28th September, 1956, under the auspices of the V.D.I.–V.D.E. Special Group for Control Engineering and the Special Committee for Mathematics of Regulation of the Gesellschaft für Angewandte Mathematik und Mechanik (G.A.M.M.). The main subjects to be covered have been provisionally fixed as (i) the value and use of the theory of control mechanisms; (ii) elementary methods of treatment, including practical experience; (iii) mathematical methods applied to regulation; and (iv) future prospects for calculating machines, regulators, etc. The particular emphasis of the convention is to link theory and practice in control engineering. Members of The Institution are invited to participate, and details of proposed papers should reach the V.D.E. Secretariat, Frankfurt/M, Osthafenplatz, 6, Germany, not later than the 1st January, 1956. The completed manuscripts will be required by the 1st April, 1956, so that they may be printed in advance of the convention. Special language arrangements are being made.

ADVISORY COUNCIL ON SCIENTIFIC POLICY

REPORT ON THE RECRUITMENT OF SCIENTISTS AND ENGINEERS BY THE ENGINEERING INDUSTRY

The Advisory Council on Scientific Policy, which is responsible for advising the Lord President of the Council, has recently issued a report on some problems affecting the recruitment of graduates and apprentices by the engineering industry; this was prepared by the Council's Committee on Scientific Manpower and describes the results of an inquiry among some leading industrial engineering firms and a few nationalized industries. Certain firms have recently viewed with misgiving the expansion of higher technological university education. One of the main fears is that those who study engineering at the universities are likely to be lost to industry for too long, and to do research of little industrial value.

The results of the inquiry show that there is a substantial unsatisfied demand—about 25% of the total—for engineering graduates. The Committee points out that this shortfall must grow unless the universities' output can be increased. Some firms believe that a university expansion will affect the numbers and quality of boys available for apprentices, but the Committee does not consider this is a real danger, since an ample reservoir of talent exists in the country. It emphasizes that more post-graduate instructional courses—as against University research—are urgently needed.

The report describes briefly the existing apprenticeship schemes in the engineering industry, and summarizes the varying views about the relative values of training the "hard way" and university training.

The report is obtainable from Her Majesty's Stationery Office, price 1s. 3d.

A COURSE ON NUCLEAR PARTICLE TECHNIQUES

A course of 13 lectures on Nuclear Particle Techniques will be given in the New Year at the Borough Polytechnic, London, by members of the staff of the Atomic Energy Research Establishment and by physicists from the London medical schools. The lectures will take place on Tuesday evenings, beginning on the 17th January, 1955. They will cover the fundamentals of nucleonic instruments and their applications to industry, medicine and nuclear reactors.

Particulars of the course may be obtained from the Secretary, Borough Polytechnic, Borough Road, London, S.E.1.

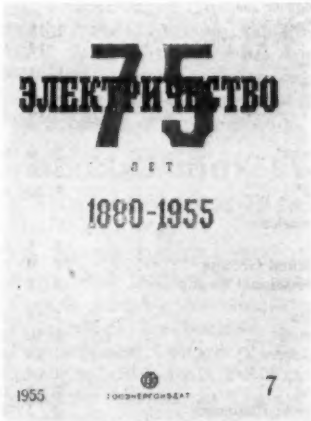
STUDENTS' QUARTERLY JOURNAL

The contents of the December issue of the *Students' Quarterly Journal* are as follows:

"Hydro-electric Development," by A. M. Howatson, B.SC.
"Air Cleaning by Electricity," by A. R. Petheram, B.SC.
"Tape Recording," by P. I. Clare.
"Street Lighting," by A. A. Marshall.
"Galloping and Vibration in Overhead Line Conductors," by R. A. E. Quartermaine.
"Tripping of Impulse Generators," by T. E. Broadbent, M.SC., B.SC.(ENG.).
"The History of Electric Street Traction," by G. Street.
"The M.K.S. System of Units," by D. J. Vermeulen, B.SC.(ENG.).
"Vacuum Techniques," by N. L. Potter, B.SC.(ENG.).
"The Utilization of Electrical Power in Rhodesian Copper Mines," by L. N. Hulley, B.SC.

ELEKTRICHESTVO

This year the Russian electrical engineering journal *Elektrichestvo* celebrates its 75th anniversary. Beginning publication in July, 1880, as an organ of the Imperial Russian Engineering Society, it is now published under the auspices of the Academy of Sciences of the U.S.S.R., the Ministry of Electric Power Stations and the Ministry of Electrical Engineering Industry. *Elektrichestvo* has remained remarkably unchanged over the years, the lettering of the title on the cover page of the anniversary number reproduced here being identical with that of the first issue. The journal publishes articles of a high technical standard and a reasonable balance is maintained between practical and theoretical. Reviews of electrical engineering progress outside the Soviet Union appear regularly and a helpful feature recently introduced is the inclusion of abstracts, suitable for card mounting, of articles both in *Elektrichestvo* itself and in other Russian and foreign electrical engineering periodicals.



Forthcoming Events at Savoy Place

All meetings are held at Savoy Place, beginning at 5.30 p.m. (tea at 5 p.m.), except where otherwise stated. The nature of the meeting is indicated by the following key:

E	EDUCATION DISCUSSION CIRCLE	**R**	RADIO AND TELECOMMUNICATION SECTION
I	INFORMAL	**S**	SUPPLY SECTION
M	MEASUREMENT AND CONTROL SECTION	**U**	UTILIZATION SECTION
O	ORDINARY		

After each paper that has now been published is added the month that its synopsis appeared in the *Journal*.

1956

JANUARY

5 *Thursday*
T. LAWRIE, C.B.E., M.A. **O**
"Highland Water Power—The Developments of the North of Scotland Hydro-Electric Board" (Paper No. 1909 S)‖ *Synopsis:* September 1955
(Mr. Lawrie died in August, 1955. His paper will be read by Mr. A. A. Fulton, of the Hydro-Electric Board)

6 *Friday*
G. F. KENNEDY, M.A., *and* F. J. HUTCHINSON, M.ENG.
"Power Station Auxiliary Plant"
(Joint meeting with The Institution of Mechanical Engineers in its building at 1 Birdcage Walk, Westminster, S.W.1; advance copies of the paper are available from the Secretary of The Institution of Mechanical Engineers)

9 *Monday*
THE PRESIDENT will open a discussion on "The Efficient Use of Technical Personnel"* **I**

10 *Tuesday*
H. E. DANCE, M.ENG., will open a discussion on "Teaching Electrical Engineering to Mechanical Engineering Students"* **E**
(Joint meeting with the Education Group of The Institution of Mechanical Engineers). (At 6 p.m., tea at 5.30 p.m.)

11 *Wednesday*
R. F. ROUS, B.SC. **R**
"Pulse-Time-Modulation Terminals for Music Transmission over Radio Links" (Paper No. 1900 R)‖ *Synopsis:* September 1955

16 *Monday*
WILLIS JACKSON, D.SC., D.PHIL., DR.SC.TECH., F.R.S., H. D. MORGAN, M.SC.(ENG.), *and* PROFESSOR G. F. MUCKLOW, D.SC. "Advanced Courses for Engineers in Industry"
(Joint meeting with The Institutions of Civil and of Mechnical Engineers at The Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, S.W.1; advance copies of the paper are available from the Secretary of The Institution of Mechanical Engineers)

17 *Tuesday*
P. BAXTER **M**
"A New Meter for the Kilovolt-Ampere-Demand Charge" (Paper No. 1927 M)‖

18 *Wednesday*
Section Dinner-Dance (at the Café Royal) **U**

19 *Thursday*
L. GOSLAND, B.SC. **U**
"Age and the Incidence of Fires in Electrical Installations" (Paper No. 1938 U)§

23 *Monday*
E. L. WIBLIN, M.A. **R and M**
Informal Lecture on "Particle Accelerators"‡

25 *Wednesday*
H. G. BELL, M.SC.TECH., will open a discussion on "Co-ordination of Overload Capacity"† **S**

31 *Tuesday*
C. A. OLDHAM *and* G. N. HARDING will open a discussion on "The Design and Use of Electrical Measuring Instruments for Arduous Conditions of Service"† **M**

31 *Tuesday*
BRYAN DONKIN, B.A., C. M. JOHNSTON, *and* E. OCKENDEN
"The Pimlico District Heating Undertaking—Costs and Financial Results"
(Joint meeting with The Institution of Civil Engineers in its building at Great George Street, Westminster, S.W.1; advance copies of the paper are available from the Secretary of The Institution of Civil Engineers)

British Nuclear Energy Conference

JANUARY

18 *Wednesday*
A meeting sponsored by The Institution of Mechanical Engineers to be held at The Institution of Civil Engineers, Great George Street, S.W.1. No tickets of admission are required.

W. B. HALL, B.SC.(ENG.) *and* T. I. M. CROFTS
"The Use of Sodium and Sodium–Potassium Alloy as a Heat-Transfer Medium"¶

* No advance information will be available.
† An abstract of the introduction will be available in advance.
‡ A synopsis will be available in advance.
§ This paper will be published not later than 10 days before the date of reading.
‖ This paper has now been published separately (see p. 762).
¶ For synopsis, see p. 763.

Contents of the Current Issues of the Proceedings

DATE OF JOURNAL DIGEST OR SPECIAL ARTICLE	
	PART A. POWER ENGINEERING (DECEMBER 1955)
February 1955	E. W. GOLDING, M.SC.TECH. **Electrical Energy from the Wind** (PAPER NO. 1727 S, NOVEMBER 1954)
	SING-YUI KING, B.SC.(ENG.), PH.D. **Interruption of A.C. Circuits** (ABSTRACT NO. 1912)
June 1955	J. CHRISTIE, H. LEYBURN, B.SC.(ENG.), AND J. F. BIRD, M.C., B.SC. **Proving the Performance of Circuit-Breakers, with particular reference to those of Large Breaking Capacity** (PAPER NO. 1707 S, AUGUST 1954)
June 1955	J. CHRISTIE, H. LEYBURN, B.SC.(ENG.), AND R. W. FENN, M.ENG. **A New Testing Station for High-Power Circuit-Breakers** (PAPER NO. 1736 S, DECEMBER 1954)
Digest not yet published	W. HOLTTUM, M.ENG. **The Installation of Metal-Sheathed Cables on Spaced Supports** (PAPER NO. 1814 U, APRIL 1955)
	Discussion on **Development and Utilization of Hydro-Electric Power in Uganda** before the North-Western Centre
June 1955	G. F. PEIRSON, A. H. POLLARD, B.SC., AND N. CARE. **Automatic Circuit Reclosers** (PAPER NO. 1717 S, DECEMBER 1954)
Special article not yet published	G. L. E. METZ. **The Electrical Engineering Industry in the Post-War Economy—II** (PAPER NO. 1795, FEBRUARY 1955)
June 1955	H. I. ANDREWS, PH.D., M.SC. **The Adhesion of Electric Locomotives** (PAPER NO. 1797, APRIL 1955)
August 1955	D. B. IRVING, B.SC. **The Supply of Electricity in the London Area** (PAPER NO. 1748 S, NOVEMBER 1954)
Digest not yet published	J. H. FIELD. **The Representation of Impedances on the Resistance Network Analyser** (PAPER NO. 1894 S)
	Discussion on **Design and Constructional Features of a Special Duty 275-kV Transformer Bank** before the North-Eastern Centre
December 1955	E. B. FRANKLIN. **The Solution of Gas in Oil during Transformer Filling** (PAPER NO. 1870 S)
Digest not yet published	J. H. BANKS, M.SC. **Multiple Fault Analysis of Delta-Star Transformer Banks** (PAPER NO. 1910 S)
	G. M. MULHERN AND D. W. O'NEILL **New Design of Control Installations for Transmission Stations** (ABSTRACT NO. 1919)
Special article not yet published	D. MAJOR, B.SC., B.A., F. R. PERRY, M.SC.TECH., AND K. PHILLIPS, M.SC. **A 20 MeV Betatron for X-Ray Therapy** (PAPER NO. 1886)
	Discussion on **Short-Circuit Forces on Turbo-Alternator End-Windings** before the South Midland Centre
	Digest of an Institution Monograph: M. E. ZEIN EL-DINE, PH.D., AND H. TROPPER, PH.D. **The Electric Strength of Transformer Oil** (MONOGRAPH NO. 135 S, JUNE 1955)
	PART B. RADIO AND ELECTRONIC ENGINEERING (NOVEMBER 1955) See November *Journal* page 726.
	PART C. MONOGRAPHS (SEPTEMBER 1955) See September *Journal* page 620.

District Meetings

Arrangements for the rest of the first half of the session for District meetings other than those in the area of a Local Centre.

1956 January	24	*Tuesday*	**HATFIELD** (At the Hatfield Technical College at 7 p.m. Tea at 6 p.m.) C. A. CAMERON BROWN, B.SC. "The Use of Electricity in Agriculture"*
January	3	*Tuesday*	**MAIDSTONE** (At the Prince of Wales Hotel, Railway Street, Chatham, at 6.30 for 7 p.m.) D. P. SAYERS, B.SC., M. E. LABORDE, ING.E.S.E., L.ÈS.SC., *and* F. J. LANE, O.B.E., M.SC. "The Possibilities of a Cross-Channel Power Link between the British and French Supply Systems" [*Proceedings I.E.E.*, Paper No. 1588 S, September 1954 (**101**, Part I, p. 284)]
January	11	*Wednesday*	**OXFORD** (At the Southern Electricity Board, 37 George Street, Oxford, at 7 p.m.) R. A. PEDDIE, B.SC.(ENG.) "Atomic Energy Programme"*
January	16	*Monday*	**READING** (At the George V Room, George Hotel, King Street, Reading, at 7.15 p.m.) L. H. HUBBLE. "Developments in Lighting Techniques"*

* No advance information will be available.

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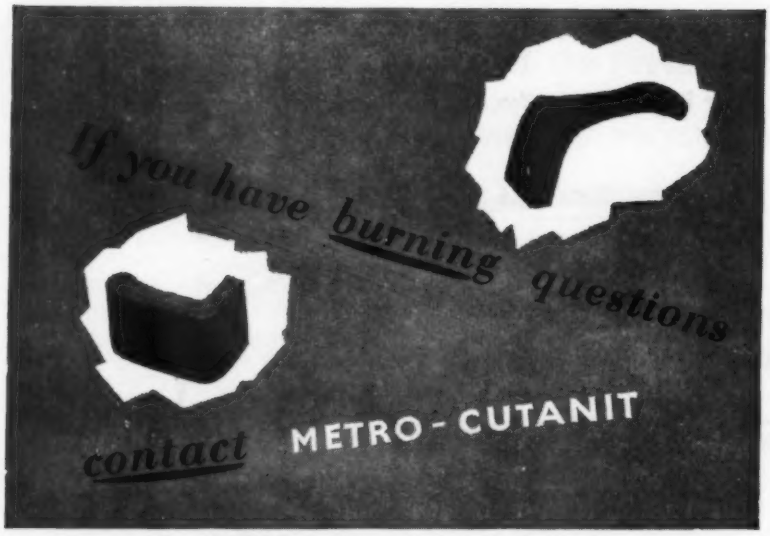

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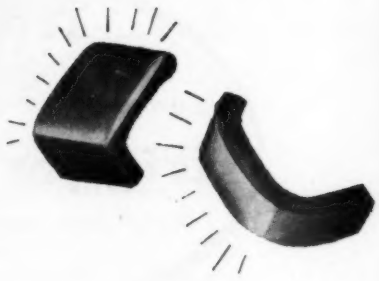

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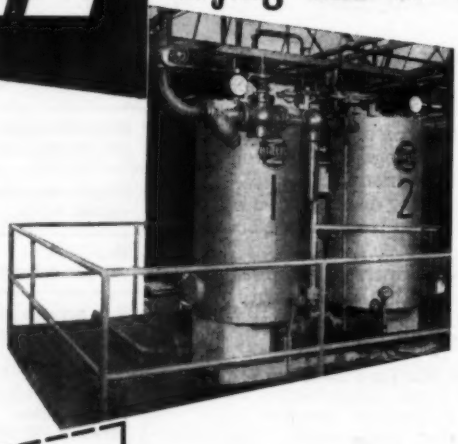

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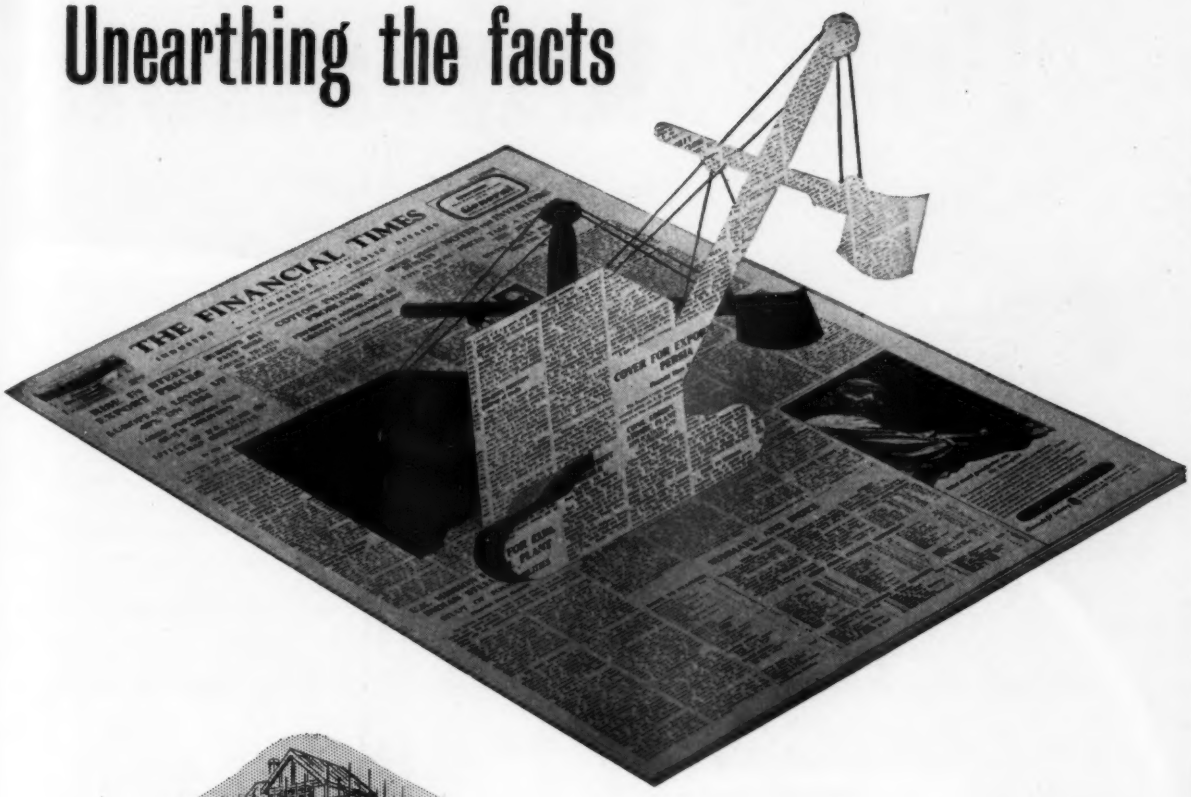

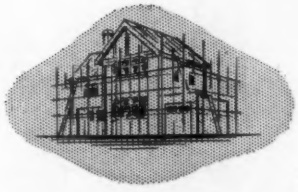

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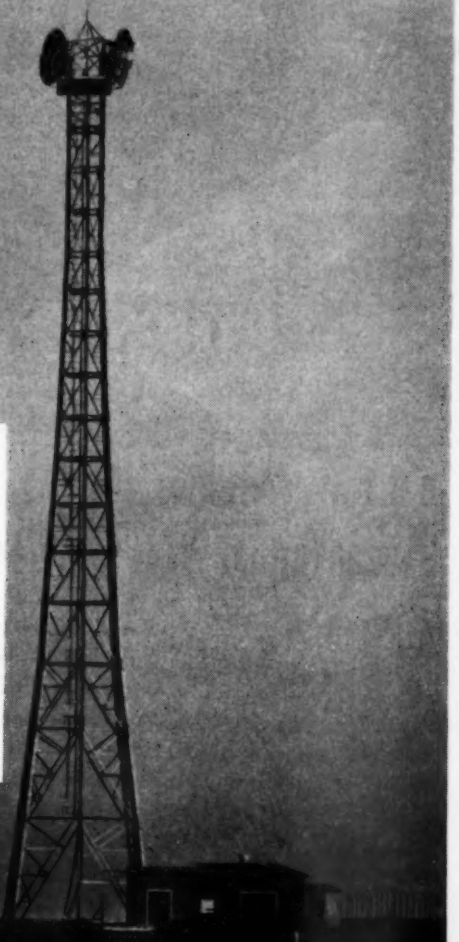

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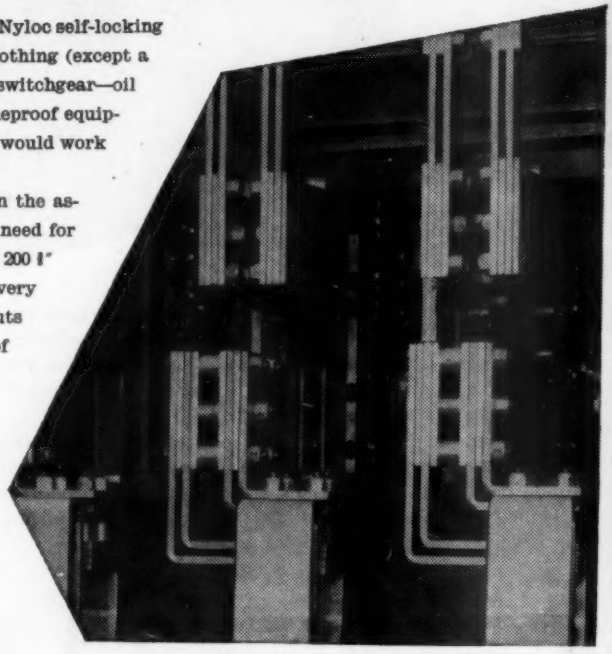

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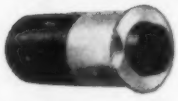

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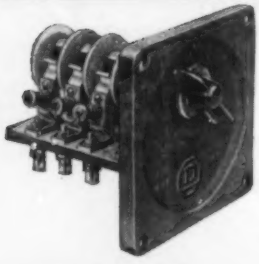

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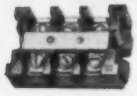

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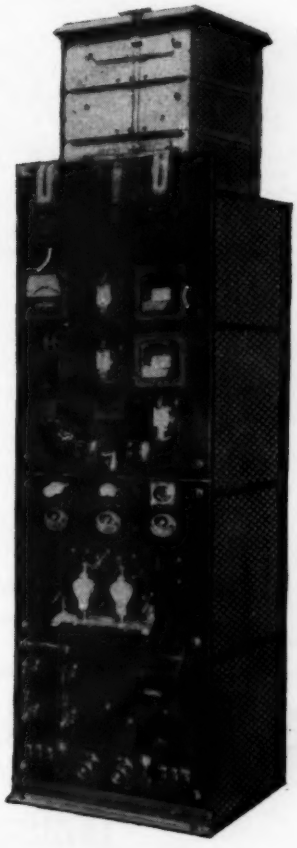

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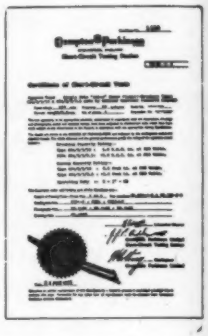

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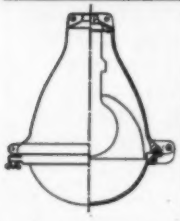

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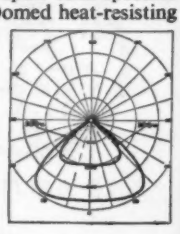

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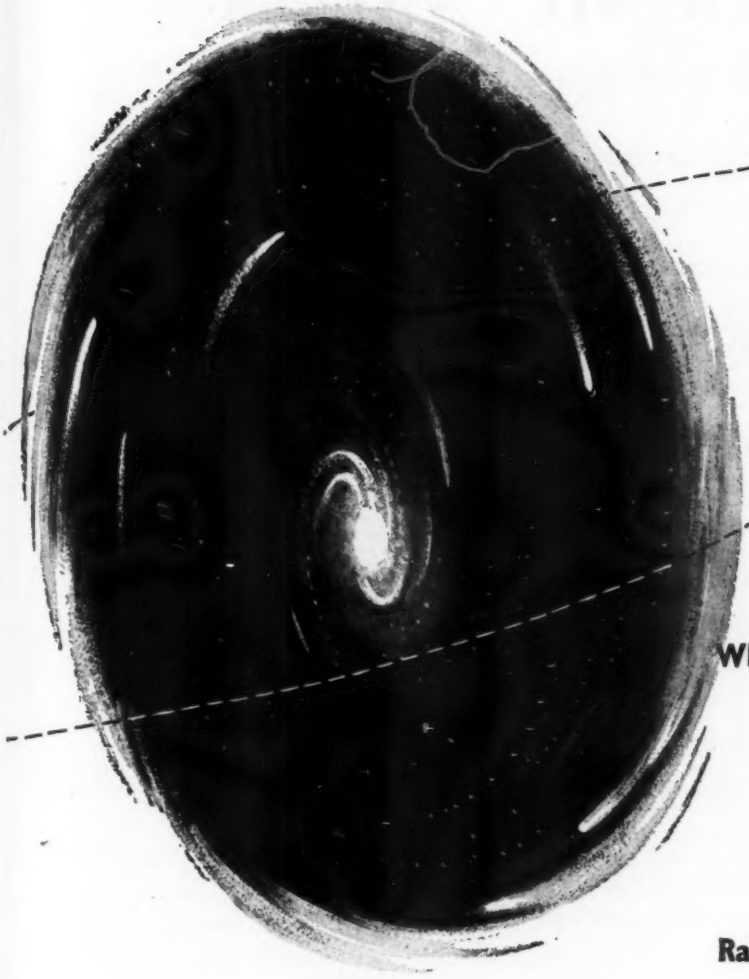

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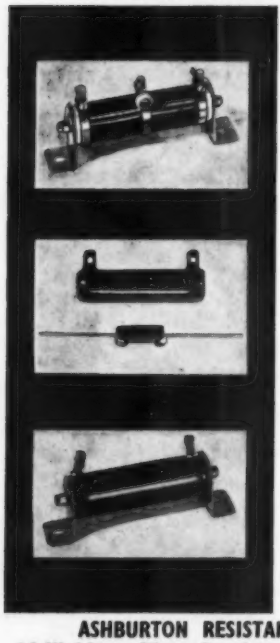

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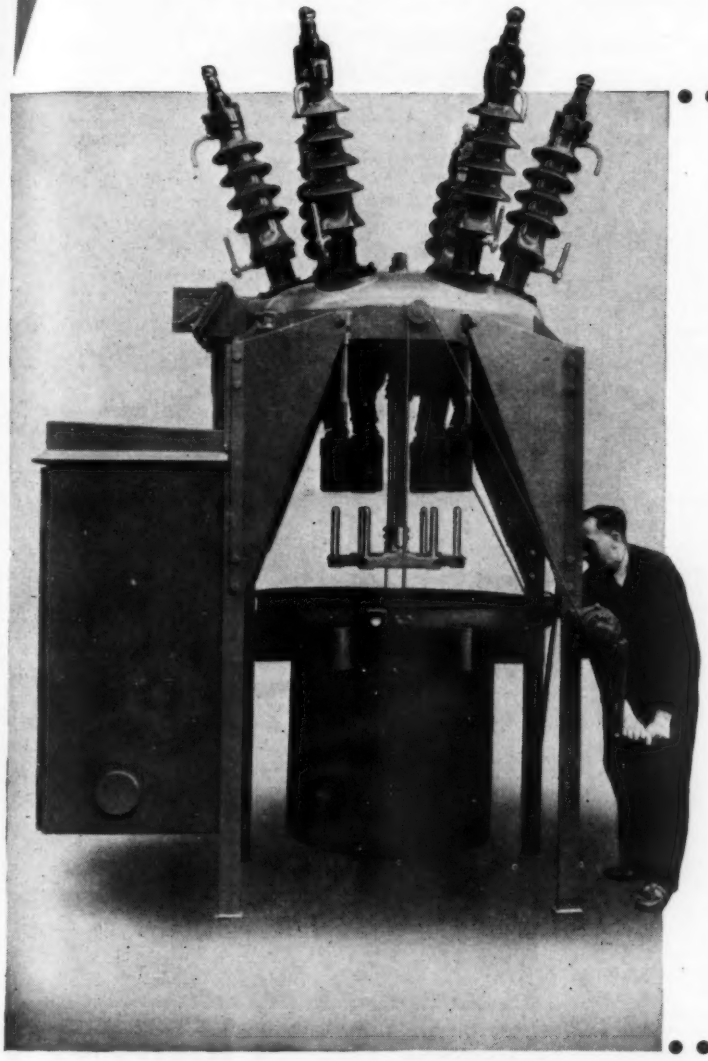

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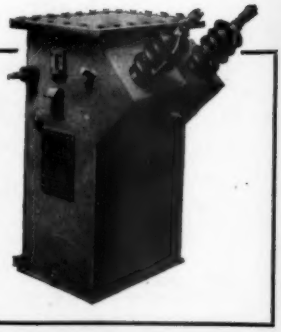

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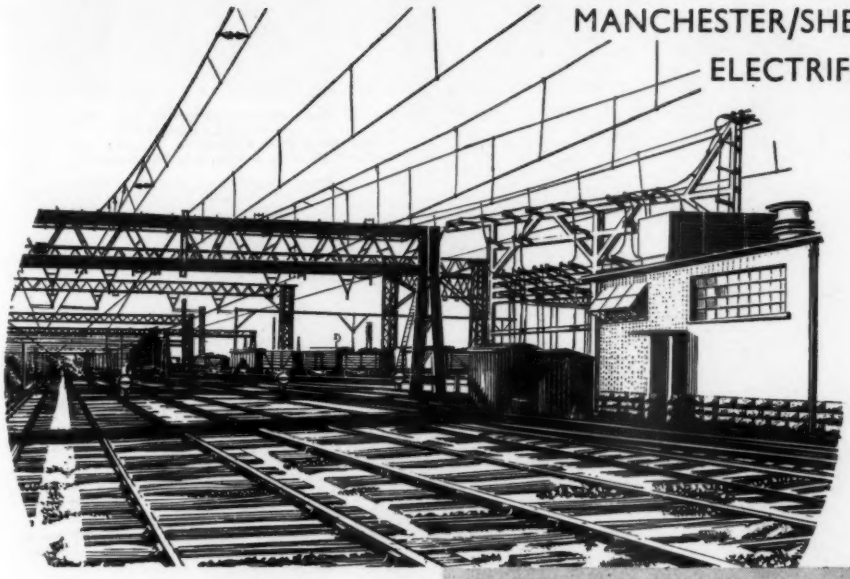

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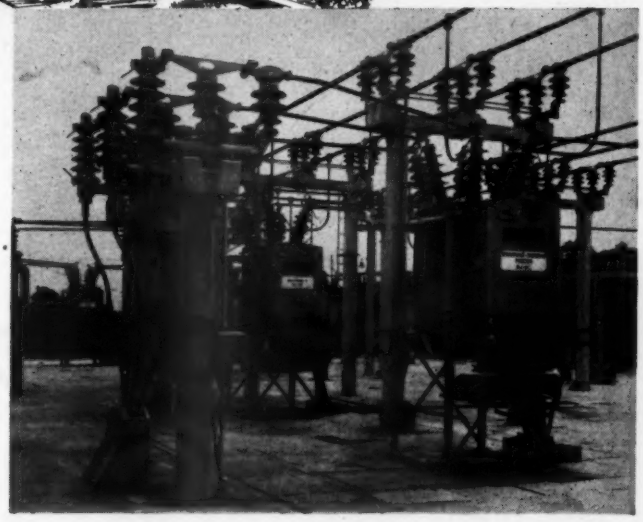

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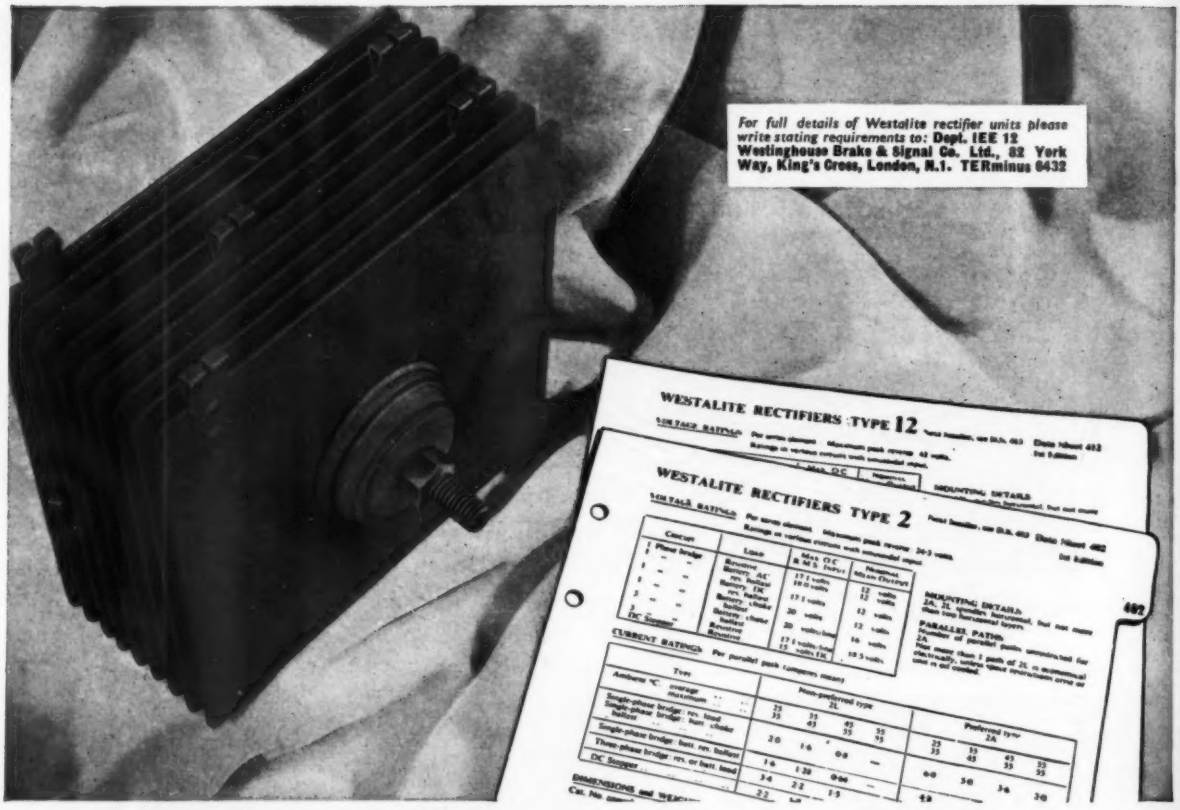
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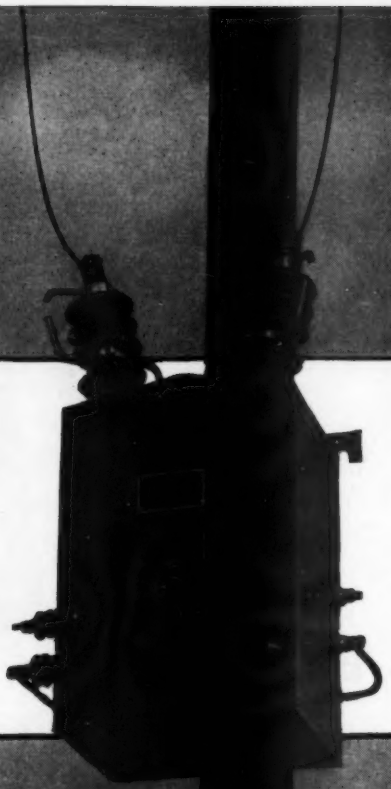

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